**TABLE OF CONTENTS**

Rationale for Adjuvant Use........................................................................................................ 2
Managing Constraints to Pesticide Performance  
with Adjuvant Products.................................................................................................................. 2
Points to be Considered when using Adjuvants  
with Pesticides.................................................................................................................................. 3
Adjuvants : A Look to the Future ...................................................................................................... 4
Adjuvant Classification.......................................................................................................................... 5
Adjuvant Functionality and “Effect” ..................................................................................................... 8
Surfactant Properties and Behavior .................................................................................................... 9
Surfactant Molecular Behavior in Water............................................................................................... 11
Conclusion ............................................................................................................................................ 12
Sources of Information on Adjuvant Use.............................................................................................. 13

LECI-TECH® (Soy Lecithin-Based Adjuvants).................................................................................. 14
LI 700® .................................................................................................................................................. 20
Effect of pH on Pesticides....................................................................................................................... 21
LIBERATE® .......................................................................................................................................... 22
MSO® CONCENTRATE with LECI-TECH® ...................................................................................... 24
VALID® .................................................................................................................................................. 26

ADDITIONAL ADJUVANTS
SUPER SPREADER ............................................................................................................................... 28
XA OIL CONCENTRATE ....................................................................................................................... 29
ALL CLEAR® ........................................................................................................................................... 30
FLUSH® ................................................................................................................................................... 31
CHOICE® Weather Master .................................................................................................................... 32
E-Z MIX .................................................................................................................................................. 34
FIGHTER-F® 12.5 ..................................................................................................................................... 36
BREAKER® ............................................................................................................................................ 37
Causes of Foam Production ................................................................................................................ 37
POD-STIK® .......................................................................................................................................... 38
TREKKER TRAX® ................................................................................................................................. 39

TURF AND SPECIALTY PRODUCTS
AQUAMARK® WSP ............................................................................................................................... 41
BLUETRAX™ HC .................................................................................................................................... 42
RESPOND® 3 .......................................................................................................................................... 43
SCENT WINTERGREEN ........................................................................................................................ 44

REFERENCE INFORMATION
Proper Tank Mixing Procedures ......................................................................................................... 46
Nozzle Outputs ....................................................................................................................................... 48
Aircraft Calibration ................................................................................................................................. 49
Computing Plant Populations and Yields ............................................................................................. 49
Measurements and Conversions .......................................................................................................... 50
Index ....................................................................................................................................................... 52

*Always read and follow product label directions and recommendations.
Rationale for Adjuvant Use

The need for food, fiber and timber has soared along with increases in world population. The expansion of world agriculture production will be one of the most demanding challenges of the future. As we strive for higher yields to fill this demand, utilizing the most effective and cost efficient agricultural inputs is imperative. Research demonstrates that the performance of inputs such as pesticides, fertilizers and plant growth regulators are constrained by several identifiable factors. Many of the factors that limit performance can be alleviated or managed with specific adjuvant products.

Managing Constraints to Pesticide Performance with Adjuvant Products

I. Water
   A. pH (acidity/alkalinity) - Managed with Acidification Agent (Acidifiers), or Alkalinization Agents.
   B. Water hardness (mineral content) - Managed with Water Conditioning Agents.

II. Spray droplet formation (atomization)
   A. Size (small droplet component) - Managed with Drift Reduction Agents.
   B. Size distribution within the droplet spectrum - Managed with Drift Reduction Agents and Adjuvants with droplet size management properties.

III. Drop impact behavior
   A. Losses due to bounce, shatter and run-off - Managed with Deposition/Retention Agents (Stickers). Initial retention will also be affected by this type of adjuvant.

IV. Post-impact drop behavior
   A. Spreading of individual droplets influenced by surface tension of water - Managed with Surfactants / Spreaders / Wetters, utilized at low rates.
   B. Retention (rainfastness) - Managed with Deposition / Retention Agents (Stickers).
   C. Distribution of droplets upon the target surface - Managed with a variety of adjuvant products such as Deposition / Retention Agents and some penetrating adjuvants such as LI 700®.
V. **The Target**  
A. **Waxy cuticular surfaces (primary barrier to uptake and penetration)** - Managed with PENETRATING AGENTS, which can actively disrupt the cuticle.  
The following adjuvant types are utilized as penetrating agents:  
1. **Oils** - containing varying levels of emulsifiers:  
   (a) Petroleum/paraffinic - Crop oils, Crop Oil Concentrates  
   (b) Vegetable based - Various sources of oils  
   (c) Chemically modified vegetable oil - Methyl/ethyl esters  
2. **Conventional surfactants/wetters/spreaders utilized at high rates.**  
3. **Specifically designed surfactant/penetran product as LI 700, which contain soybean extracts.**
B. **Sub-cuticular tissues (can also act as barriers but more to the translocation of absorbed materials)** - Managed with adjuvants having the ability to actively assist translocation. **LI 700** has been documented as being a TRANSLOCATION AGENT.  
C. **Dust or Plant Exudates** - managed with adjuvants that neutralize compounds that can lower pesticide efficacy.

---

**THE FOLLOWING POINTS REGARDING ADJUVANT PRODUCTS ARE IMPORTANT AND SHOULD BE CONSIDERED AS THEY ARE BEING UTILIZED WITH PESTICIDES:**

- **Adjuvants are not pesticides.** They should be considered as tools to assist the management of pesticide performance.
- **Adjuvants are not all alike.** They differ greatly in their properties (chemistry), function, dose requirements, specificity of use and quality.
- **Performance of pesticides is highly interactive with numerous factors.** Examples: method of application, environmental conditions, target pest, crop stage, pest pressure, water quality, coverage pesticide rotation, residual activity, timing and tank mixing.
- **It is important to be able to identify factors that constrain the performance of pesticides.** Many can be managed with the use of adjuvant products.
- Individual constraining factors (i.e. water pH) may be small, however it is important to realize that when several “small or seemingly insignificant” factors occur simultaneously, they can combine to produce an overall large effect.
- **Know the adjuvants you use.** Find out what properties they have and what dose is required to achieve optimum results.

*Always read and follow product label directions and recommendations.*
INTRODUCTION

Within the range of currently available agrichemical products, there exists a unique group of products called adjuvants. These products have the ability to greatly influence the performance of pesticidal materials by working through both physical and chemical processes. Adjuvants should be considered as management tools that can enhance the level and consistency of performance. Improvement in these areas can be attributed to the ability of the adjuvant to compensate for the variables that impact performance.

The use of adjuvant products as management tools for agrichemical application will provide measures to:
1. Improve or otherwise facilitate the physical handling characteristics of agrichemicals.
2. Improve performance effectiveness and consistency by:
   a. Reduction or minimization of pesticide losses.
   b. Enhancing or maximizing the effect of pesticides.
3. Comply with legal requirements for their use.

Clearly, the expansion of world agriculture production will be one of the most demanding challenges of the future. The ability to improve production efficiency will be closely tied to agrichemicals. As adjuvant products have demonstrated their utility in enhancing agrichemical performance, there is little doubt that adjuvants will play an increasing role in the future.

Loveland Products Canada, Inc. will continue to be active in three areas with regard to adjuvants:
1. Research and development of unique and functional products to meet the specific and changing needs of the agrichemical industry.
2. Manufacture of quality products according to state of the art procedures and adherence to strict quality control standards.
3. Distribution, both domestically and internationally, to organizations attuned to handling specialty products.

Loveland Products Canada, Inc. is dedicated to the support of its clientele by providing technical expertise, training and superior promotional efforts to the product line. Our company offers a full line of adjuvants and remains on the cutting edge of adjuvant development. The following sections will contain information regarding adjuvant categories, terminology and mode of action.
ADJUVANT CLASSIFICATION

As a matter of convenience, adjuvants can be grouped into several distinct categories. The following is a list of these categories.

A. **Surfactants:** The word surfactant is the shortened form of “surface-active agent”. These compounds are commonly referred to as spreaders or wetting agents. The primary function of any surfactant is to reduce the surface tension at the interface of a spray droplet and the leaf surface it is in contact with.

   - *LI 700 Liberate® Super Spreader*

B. **Penetrating surfactants:**
   In addition to surface tension reduction these surfactants also penetrate the waxy cuticle of the leaf to further enhance pesticide uptake.
   1. **Soybean oil derivatives:**
      - *LI 700 Liberate MSO® with Leci-Tech®*
   2. **Methylated seed oils:**
      Occasionally referred to as methyl esters. The products in this group are specific in their adjuvant effect. They function exceptionally well with many herbicide chemistries. Vegetable seed oils all contain constituents called fatty acids. These organic acids may be transformed by a process called esterification by reacting with an alcohol. In methyl ester production, the fatty acids are esterified with methyl alcohol. The end result is a seed oil with new properties of solvency and water affinity.
      - *MSO with Leci-Tech*
   3. **Emulsified petroleum based oils:**
      Commonly called crop oil concentrates or oil surfactants. The usual ratio is 16 to 20% surfactant emulsifier and 84 to 80% petroleum based oil.
      - *XA Oil Concentrate*

C. **Water conditioning agents:**
   When certain herbicide chemistries, such as glyphosate, sulfonylurea, imidazolinone, and phenoxyes are added to water, the negative charges in the herbicide molecules attract the positive ions (cations) in water (i.e. calcium, iron and magnesium). The herbicide and these cations form a strong complex, which can prevent or hinder uptake of the herbicide into the plant, effectively reducing herbicide performance. Water conditioners sequester and chelate cations freeing the herbicide molecules to perform more effectively.
   - *Choice® Weather Master*

*Always read and follow product label directions and recommendations.*
D. **Nitrogen containing additives:**
These products have historically been used with herbicides, and are sometimes regarded as anti-antagonism agents to be used in conjunction with surfactant adjuvants. Success with this type of product seems to be specific with certain herbicide chemistries, weed species and carrier volumes. The exact mode of action of this group is still being debated; however, it is generally felt that their use promotes uptake and/or translocation of the herbicide. There may be some activity related to reducing impact of certain aspects of minerals in the spray water.

E. **Droplet size management (drift reduction):**
   1. **Polymers:**
      This category of adjuvant product is usually a viscoelastic (having both viscous and elastic properties) polymer that is added to spray solutions to reduce the production of fine droplets. It is known that very small droplets (usually under 150 microns in diameter) are most susceptible to non-application as well as off-target application. Drift reduction polymers tend to increase the size and weight of droplets produced by a spray nozzle and as a consequence, reduce opportunity for losses and off-target application.

   2. **Soybean-Based:**
      It is now known that many of the polymer-based products suffer degradation and loss of function following circulation through typical spraying machinery. Additionally, it is recognized that polymers can negatively alter the functionality of spray nozzles, especially in the area of flow rate and nozzle pattern angle. Loveland Products discovered that the phospholipid/lecithin-based chemistry, being used in several of their adjuvant products, did not produce attendant losses of function.

Loveland Products’ lecithin adjuvant products have consistently shown outstanding results in field crop and patternator (spray equipment) trials. These products possess properties capable of managing droplet size. Ideally, an adjuvant helps provide a spray particle distribution that contains fewer small (<150 microns) and large (>500 microns) droplets. Lecithin-based products actually improve the spray pattern and reduce drift by maintaining the proper (uniform) spray pattern as designed by the nozzle manufacturer.

*LI 700  Liberate*
*MSO with Leci-Tech  Valid®*
F. **Acidification agents:**
Products that are added to spray solutions for the purpose of lowering the pH are called acidification agents. Lowering the pH of spray mixtures will improve the stability of certain pesticides and can also prevent certain incompatibilities.

*LI 700*  
*Choice Weather Master*

G. **Compatibility agents:**
These products have utility when tank mix combinations of pesticides or pesticides and fertilizers are prepared. Problems with compatibility usually result in non-homogenous mixtures or non-applicable mixtures. Compatibility agents, which are generally heavy-duty emulsifier blends, can assist mixture problems in two ways: (1) Their use may allow mixtures to be made that otherwise would be incompatible, and (2) their use may allow some ability to salvage mixtures already incompatible into sprayable condition. The best advice is to prevent incompatibility problems by pre-testing the combination.

*E-Z Mix*

H. **Antifoam/defoam agents:**
Antifoam and defoam agents are products that are typically siloxane emulsions. They will have dual functionality in that they can be utilized to eliminate foam that has already developed (defoam) or to prevent foam under conditions where a history of foaming is known (antifoam). The presence of foam in spray mixtures can seriously impact mixing and also affect calibration of spray equipment.

*Fighter-F® 12.5*  
*Breaker®*

I. **Miscellaneous:**
1. *Tank decontaminating agents / Tank cleansers*
   
   *All Clear®*  
   *Flush®*

2. *Emulsified vegetable oils*
ADJUVANT FUNCTIONALITY AND “EFFECT”

Adjuvant formulations are designed to possess certain properties, which affect the functionality of an adjuvant. Functionality can be specifically determined by:

- The chemistry of the components,
- The proportions of the components
- The dose or quantity used

As adjuvant products are considered management tools, it will be important for users to know what properties are needed in an adjuvant and what particular adjuvant can provide those properties. Users should also be aware that, in certain situations, the addition of adjuvant properties may not produce an “effect”.

Obtaining an “effect” from the use of an adjuvant with an agrichemical will depend on the following:

- adjuvant property added and in what amount
- pesticide used and in what amount
- intended target
- application efficacy
- environmental conditions

The graph on the below represents the dose responsive nature of the pesticide and pesticide/adjuvant combination. The point should be observed that the adjuvant “effect” is inversely related to the pesticide dose. That is, a greater effect will be observed at lower rates. The “effect” of the adjuvant can be represented by the difference between the two lines.

![Typical Response Curve of Agrichemical With and Without Adjuvant](image-url)
SURFACTANT PROPERTIES AND BEHAVIOR

While it is recognized that not all adjuvants are surfactants, it is well accepted that the contribution surfactants make to the functionality of many adjuvants is extremely important. Because of this fact, the following section will be a bit larger and in more detail than other categories of adjuvant products.

The single most unique feature of a surfactant is not its’ chemistry but its’ two-part structure. Every surfactant molecule will have a distinct portion that is, to some degree, water-soluble and a portion that is, to some degree, oil soluble. It is this dual set of diverse properties that will determine its behavior and functionality. General pictorial representations of surfactant molecules are usually as follows:

A numerical scale has been established to express the relative effect of the individual portions (hydrophilic & lipophilic) of a surfactant on the overall physical and chemical properties of the molecules. The scale is called the HLB and represents the Hydrophilic Lipophilic Balance for a single surfactant molecule. The scale runs from 1 to 20 with 1 being the most lipophilic and 20 being the most hydrophilic.

Hydrophilic Lipophilic Balance of Surfactants

The limitations of the usefulness of an HLB rating is as follows:
1. Applicable to non-ionic surfactants only
2. Accurate only for single surfactant molecules
3. Not useful for mixtures of surfactants
4. Not useful for use when surfactants are used above the critical micelle concentration

*Always read and follow product label directions and recommendations.*
The most obvious and familiar property imparted to aqueous solutions by surfactants is that of surface tension reduction. Surface tension is a phenomenon caused by an unbalanced force of attraction due to cohesion. **Surface tension of liquids manifests itself by phenomena such as the curved shape of liquids in containers (the meniscus) and the fact that a liquid will draw itself into a spherical shape on a non-wettable surface.** Surface tension is also responsible for the “elastic-like” nature of the liquid surface.

As illustrated in the graph on the right, there will be a concentration point for every surfactant at which maximum surface tension depression is achieved. Surfactant added above this concentration will not depress the surface tension further, and will be represented by the beginning of the flat portion of the graph.

The point described previously is called the **Critical Micelle Concentration or CMC.** When surfactants are mixed with water, the “head” portion attaches itself to water molecules due to the polar nature of both the “head” and the water molecule. Surface tension of water is reduced and is dependent on concentration of surfactant. Reduction will be non-linear until a maximum depression is achieved. Beyond this point, the addition of more surfactant does not result in further surface tension depression.

As illustrated, surfactants will cause droplets to collapse under their own weight and increase dramatically the area of contact. This is one of the main reasons surfactants are used with pesticidal materials; that is, to improve physical coverage over the surface of the intended target.

Indicated earlier in this section was the fact that surfactants exhibit a point at which no further surface tension depression is experienced. This point is simply the limit of aqueous solubility of the surfactant.
This point is marked by another phenomena known as micelle formation. This means that the surfactant molecules no longer function and behave as monomers (single molecules). At this point, surfactant molecules clump together to form aggregate units called micelles. If the micelles are in water, they will orient themselves with their hydrophilic portion outward and their lipophilic portions inward.

**SURFACANT MOLECULAR BEHAVIOR IN WATER**

When a solution reaches or exceeds it’s Critical Micelle Concentration (CMC), the surface of the liquid can no longer accommodate additional surfactant molecules. At this concentration, the excess surfactant molecules will migrate away from the surface and aggregate to form micelles.

Micelles may have impact on pesticide activity by providing increased uptake into the target. The exact mechanism may be linked to solubilization of the waxy layer of leaves by micelles. This will be dependent on the number of micelles present and the HLB of the surfactant monomers. Other actions that may be attributable to micelles are: pesticide concentration effect, partitioning of the pesticide and the maintenance of a hydrated state of the target surface.

The following idealized graph illustrates the relationship of micelles to penetration enhancement by surfactants.

As illustrated, no significant surfactant enhancement of penetration occurs until after CMC is reached. Further shown is the relationship of increased dosage (beyond CMC) on uptake. With this

*Always read and follow product label directions and recommendations.*
information, it becomes clear that surface tension reduction alone does not significantly do anything beyond spreading or coverage enhancement. As CMC for virtually all surfactants is at or below a dose of 0.1% v/v (363 mL/454 L), it also becomes apparent as to why doses of 0.25 to 0.50% v/v are commonly recommended on many herbicide labels. These are the doses that are sufficient to accomplish penetration improvement. This fact might also lead one to ask why some adjuvant manufacturers recommend doses of surfactant significantly below CMC for products that must be taken into plants?

**CONCLUSION**

The book, *Fate of Pesticides in the Environment* (Dr. Julius J. Menn), outlines six aspects of agrichemical trends. In reviewing these trends, it becomes apparent that the use of adjuvants, as a class of agrichemical products, fit extremely well into the trends for pesticide use in the future. The following is a brief synopsis of those trends with comments on adjuvant use:

1. **New agrichemicals are trending toward more active molecules delivered in very concentrated formulations.** Generally, they will be more expensive and will use smaller quantities than conventional pesticides. Adjuvants will fit into the scheme of more effective application (deposition and retention) as the margin for application error becomes smaller.

2. **Agrichemical rate reduction.** Through general practice as well as through regulation, the main goal will be to reduce the environmental load of agrichemicals. Adjuvants have a historical base in rate sparing and many attempts at reduction have been successful only with the addition of adjuvants.

3. **Changing agronomic practices and improvement in pesticide delivery system.** With the continued adoption of no-till and minimum till regimes the use of more post-emergent pesticide products is borne out of necessity. Adjuvants have an excellent base of performance enhancement for post-emergence agrichemicals.

4. **Management of pest resistance.** The recognition and management of resistance to agrichemicals by various strategies will be a huge challenge. One strategy is to insure better initial control of pests, which can slow down resistance development. Improved performance consistency of pesticides by use of adjuvants will be an integral part of this strategy.

5. **Impact of IPM program on pesticide use patterns.** The overall effect may be to reduce the amount and frequency of use of pesticidal materials. In either case, it will be important to do everything possible to insure the highest level of performance, i.e., adjuvant utilization.

*Always read and follow product label directions and recommendations.*
6. **The effect of national and provincial regulatory activities on types of pesticides marketed.** Trends will be toward more selective, “softer” pesticides with less persistence and rapid biodegradability. As in section 5 above, all efforts should be made to insure the most efficient level of performance such as incorporation of adjuvants.

**SOURCES OF INFORMATION ON ADJUVANT USE**

The first and foremost source of information is the pesticide label itself. Increasingly, pesticide manufacturers include information on recommended adjuvant type, ionic classification, rate, minimum percent activity, as well as general use cautions. The Internet is another source of information. Basic manufacturers, agrichemical marketing companies, publishers of farm publications and journals, universities, etc. have websites, which post everything from specific product information to research results. Adjuvant formulators often have brochures and other literature pieces on adjuvants available.
SOY LECITHIN-BASED ADJUVANTS
SURFACTANCY, ADHESION, PENETRATION, ATOMIZATION CONTROL, INCREASED DEPOSITION

Lecithin derivatives are obtained from the hydrogenation/ hydroxylation of natural soya lecithin and refined using special techniques. Biochemically, it is a lipid material belonging to the phospholipid class and is a component of all living cells. Most performance benefits of lecithin come from the unique surface-active properties of phospholipids. As molecules, phospholipids contain hydrophobic and hydrophilic elements. The hydrophobic portion has an affinity for fats and oils and the hydrophilic portion has an affinity for water. Because of this affinity, these products work well with oil-soluble- and water-soluble-herbicides. They are very safe biosurfactants with superior heat and oxidation stability. The products based on this chemistry are not subject to the issues of pump shear degradation (loss of drift reduction function of spray solution following pump circulation), reduction of nozzle fan angle and compatibility problems with most pesticide formulations.
Loveland Products
Protecting Crops with Crop Based Products

Loveland Products, has worked with lecithin technology for over 20 years. It takes anywhere from 5.2 - 18.7 kilograms of soybeans to make 1 litre of adjuvant containing Leci-Tech. This technology supports North American soybean growers as Loveland Products continues to advance its Leci-Tech formulations for end-use plant protection and nutrient products.

Products containing Leci-Tech provide a unique chemistry that works in a variety of row crop, vegetable, small grain, turf and ornamental as well as non-crop applications. Ensuring food and feed safety and security, Leci-Tech chemistry allows for lower use rates, added crop safety and is biodegradable ensuring environmental sustainability.

LECI-TECH chemistry allows for improvements in surfactant activity, spray droplets adhesion, plant cuticle penetration and optimal spray droplet size. In fact Loveland Products Canada currently has 4 products in Canada with Leci-Tech technology; LI 700, Liberate, MSO Concentrate with Leci-Tech and Valid, contributing to the success of Canada’s agricultural sector.

Loveland Products is looking to Leci-Tech technology to make improvements in existing product formulations as well as new products formulations coming to market to further assist crop protection.

EXCEPT MORE WITH LECI-TECH SUPERIOR PENETRATION

To maximize performance of both systemic and contact pesticides it is critical to ensure penetration through the leaf cuticle. This is especially important when targeting plants are under environmental stresses or that have a naturally occuring thicker cuticle.

The Leci-Tech chemistry allows for the spray droplet to reach the critical micelle concentration (CMC) at a lower concentration, providing quicker uptake versus conventional non-ionic surfactants. Leci-Tech containing products will also reduce evaporation, allowing for greater solubility and uptake.

*Always read and follow product label directions and recommendations.*
EXCELLENT SPREADING PROPERTIES

With many pesticides, coverage is the primary objective for optimum performance. The Leci-Tech technology will aid in the reduction of surface tension, allowing for better pesticide dispersion on the plant surface.

DROPLET ADHESION

Adhesion is improved with Leci-Tech containing product by reducing bounce and shatter of the spray droplets upon contact with the plant leaf surface. Droplets will stay on the plant, providing more consistent control.

DRIFT MANAGEMENT

Drift reduction is critical when spraying certain pesticide formulations. Spray patterns are generalized into 3 categories based on the diameter of the droplet. They are driftable fines, desirable and too large. Driftable fines are those spray particles that have diameters below 150 microns. Desirable droplets are between 150 to 500 microns. The higher the percentage of desirables contributes to better coverage and performance of the pesticide being applied. Particles above 500 microns are deemed too large as they are detrimental to good coverage because of their being prone to bouncing, shattering or rolling off target surfaces upon impact.

Correct nozzling, pressure and ground speed are used to manage drift. One often overlooked aspect of drift is the composition of the spray solution being applied. A final spray solution consists of water, the type and rate of the pesticide being used and any other additives/adjuvants that may be included. As an example alcohol based non-ionic surfactants generally increase the number of

*Always read and follow product label directions and recommendations.
driftable fines in a spray pattern and thereby increase the risk of drift, especially when compounded with other application factors. Many independent studies have shown that adjuvants containing *Leci-Tech* technology decrease the percent of driftable fines, increase the percent in the desirable range while not increasing the percent particles over 500 microns. A more uniform droplet size will aid in reducing drift, as well as provide more consistent coverage on the desired target.

**Comparison of Spray Pattern with LI 700**

![Comparison of Spray Pattern with LI 700](image)

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

<table>
<thead>
<tr>
<th>Product Combination</th>
<th>% Volume (&lt;100 micron size)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>6.5</td>
</tr>
<tr>
<td>Agril 90 + Water</td>
<td>9</td>
</tr>
<tr>
<td>LI 700® + Water</td>
<td>2.8</td>
</tr>
<tr>
<td>Roundup Transorb + Water</td>
<td>9.3</td>
</tr>
<tr>
<td>Roundup Transorb + Agril 90</td>
<td>11.2</td>
</tr>
<tr>
<td>Roundup Transorb + LI 700</td>
<td>3.2</td>
</tr>
</tbody>
</table>

**Effect of Valid on Dyvel DS Atomization**

![Effect of Valid on Dyvel DS Atomization](image)

Dyvel was used at 19oz/A – 10 GPA

Source: Thomas M. Wolf, Agriculture and Agri-Food Canada, Saskatoon Research Center (the two charts above).

*Always read and follow product label directions and recommendations.*
**CROP SAFETY**

Penetrating surfactants are designed to assist in the pesticide’s entry into the plant through the physical barrier (waxy cuticle) of the target plant surface. While effective, there is an appreciable risk of crop damage as this is a non-selective procedure. Penetrating Surfactants containing *Leci-Tech* don’t break down the waxy layer but act as an extremely effective penetrant by opening it up without damaging and provide a crop safe alternative to improving systemic herbicide uptake and efficacy.

---

**Effect of Penetrating Surfactants on Leaf Surface**

This is a normal leaf surface. The wax structure is tightly packed together. This is the normal, protective barrier of the leaf.

After the addition of *LI 700 with Leci-Tech*, the wax structure is intact but stands more erect. *LI 700 with Leci-Tech* enhances penetration by temporarily relaxing the wax structure.

After the addition of an oil surfactant, severe distortion of the wax structure can be seen. Breakdown of the waxy barrier may result in injury to desirable plants.
Always read and follow product label directions and recommendations.

LESS Drift, MORE Coverage, BETTER Penetration

With LI 700®, you get more from your pesticide investment. LI 700 is a non-ionic penetrating surfactant designed to enhance the performance and reliability of foliar applications.

With LECI-TECH® technology, LI 700 helps sprayer operators better manage their application risk for a higher return on their investment.

Drift control with LECI-TECH®

www.uap.ca
© 2013 Loveland Products, Inc. Always read and follow label directions. LI 700 and Leci-tech are registered trademarks of Loveland Products, Inc.
**Penetrant, Acidifier, Deposition Aid, Drift Control Agent**

*LI 700*® is a soy-oil derived, low foaming, non-ionic penetrating surfactant, that reduces off-target spray drift, and lowers spray water pH. Unique formulation technology and quality ingredients separate *LI 700* from the imitators.

**Formulation**

Phosphatidylcholine, methylacetic acid and alkyl polyoxyethylene ether ................................................................. 80%
Constituents ineffective as spray adjuvant ........................................... 20%

**Benefits**

- Surfactant properties of *LI 700* improve spray droplet deposition, adhesion and coverage of spray material on leaf surfaces.
- Penetrant properties of *LI 700* maximize the effectiveness of systemic herbicides, insecticides, fungicides, miticides, PGRs and foliar applied nutrients.
- Acidification properties of *LI 700* prevent degradation of pesticide caused by high pH water.
- Drift reduction properties of *LI 700* lower potential for off-target spray and improves deposition of pesticides.
- Soy-oil derived components in *LI 700* provide excellent crop safety and replaces petroleum-based components with farm-grown components.
- *LI 700* is a low-foaming surfactant and will not foam in the spray tank.

**Application Information***

- When used as a Penetrating Surfactant: 2.5 - 5 L/1000 L
- When used as a Drift Reduction and Deposition Aid with Glyphosate: 2.5 - 5 L/1000 L
- When used as an Acidifying Agent: 300 - 1.25 L/1000 L

Target Chemistries: Glyphosate, weak acid herbicides, insecticides, defoliants
Do Not Use with Sulphonylurea Herbicides or products containing copper

**Container Size:** 10 L; 3.78 L

*Always read and follow product label directions and recommendations.*
EFFECT OF pH ON PESTICIDES

Most pesticides are designed to function in a slightly acidic environment. High pH will impact performance of certain pesticides in 1 of 3 ways.

The first is a result of a chemical reaction to the pesticide called alkaline hydrolysis. Simply put, it the measure of the stability of pesticides with regards to pH. This stability is determined by the half-life of the product, which is the amount of time it takes for half of the material to break down at a particular pH. For most products the rate of alkaline hydrolysis is slow enough that breakdown in the field is not noticed. However there are certain pesticides where at higher pH’s rapid hydrolysis will occur, rendering the product useless as this is an irreversible process. A classic example of this is seen with Dimethoate, which can breakdown rapidly in high pH situations.

The second is the dissociation of weak-acid herbicides. These compounds are defined as a chemical compound that does not ionize or dissociate readily in an acidic solution. By reducing solution pH, the amount of the herbicide in the ionic or electrically charged form will be reduced. This impacts herbicide performance as the preferred form for entry through the leaf cuticle is the neutral or uncharged whole molecule form of the herbicide. In this neutral form, certain herbicides will not be affected by hard water conditions that can limit uptake and performance.

The third is the effect of solubility of Sulphonylurea herbicides. This class of herbicides may precipitate out at lower pH so LI 700 must not be used in tanks mixes containing this class.

*It is important to know the pH of your water source and the susceptibility of the pesticides to pH you are applying.

*Always read and follow product label directions and recommendations.
100% Active, Non-Ionic Surfactant, Defoamer

Liberate® is an uptake enhancing surfactant system. Liberate is designed for use with pesticides that recommend a non-ionic surfactant and contains soybean-based components that work especially well with systemic chemistry. Liberate provides uniform droplets allowing complete coverage and excellent control. Additional defoaming properties make Liberate very user-friendly.

Formulation

Lecithin, methyl esters of fatty acids and alcohol ethoxylate ................................................................. 100%

Benefits

- 100% active spreader/penetrant contains soy oil derivative.
- Odorless, low-foaming, neutral pH formulation.
- Contains Leci-Tech chemistry.
- Provides increased droplet adhesion, excellent penetration and deposition and is user friendly.
- Drift reduction properties of Liberate with Leci-Tech lower potential for off target spray deposition

Application Information

When used where a non-ionic surfactant is required: 1.0 - 2.5 L/1000 L

Target Chemistries: Tank mixes where sulphonylurea herbicides are used.
Fungicides that require a non-ionic surfactant.

Container Size: 10 L
NOTES
Modified Vegetable Oil and Surfactant Blend

MSO® Concentrate with Leci-Tech® is a methylated seed oil containing the highest quality components available. The premium emulsifiers along with Leci-Tech will provide uniform mixing for excellent performance as well as drift reduction, enhanced penetration and droplet adhesion. MSO Concentrate with Leci-Tech is designed for use with post-emergent herbicides and has consistently demonstrated increased penetration over conventional crop oil concentrates.

Formulation

Methylated seed oil of soybean 70% alcohol ethoxylate ................. 100%

Benefits

- Premium emulsifiers provide easy mixing.
- Use of the highest quality methyl esters available produce a product with a lower freezing point than others on the market and increased herbicide absorption for optimum weed control.
- MSO Concentrate with Leci-Tech will provide increased plant uptake vs. standard MSO formulations.

Application Information*

10 L per 1000 L spray mixture or product label recommendation. Add MSO Concentrate with Leci-Tech after pesticides are thoroughly mixed.

Target Chemistries: Imidazolinone Herbicides where a surfactant is required. Poast® Ultra and Viper®

Container Size: 10 L

*Always read and follow product label directions and recommendations.
Methylated Seed Oils (MSOs) are utilized when superior cuticle penetration is needed. MSO is often used with herbicides during hot, dry conditions. During these stressful environmental conditions, plants will develop thick waxy cuticles in an effort to conserve moisture. The demonstration above compares the differences in activity of water, crop oil and MSO Concentrate with Lect-Tech. The ability of MSO to solubilize a waxy cuticle is shown in the graph below.
Deposition Aid, Drift Control Agent, Antifoam/Defoamer

Valid® is a non-ionic adjuvant with drift control agents and an integrated antifoam/defoamer. Valid is designed specifically to enhance deposition, control droplet size and defoam spray solutions.

Formulation
Lecithin, Alcohol ethoxylate, methyl esters of fatty acid, 2,2’Dihydroxydiethyl ether, polydimethylsiloxane ... 100%

Benefits
- Does not compromise spray nozzle performance.
- Increases droplet adhesion and improves deposition.
- Contains an antifoam/defoam system.
- Contains Leci-Tech chemistry.
- Low use rates make Valid a cost-effective problem solver.
- User-friendly, liquid formulation that is compatible in all spray solutions.
- Reduces drift by producing a more uniform droplet size and spray pattern.

Application Information*
Add 1.25 L of Valid to 1000 L of spray mixture.

Target Chemistries: Use in any herbicide application where drift may be of a concern and to increase uniformity of droplet size.

Container Size: 3.78 L

*Always read and follow product label directions and recommendations.
Additional Adjuvants
Super Spreader is a non-ionic surfactant used to improve the performance of certain pesticides. Super Spreader provides improved foliage wettability through the formation of a continuous and uniform spray-solution film on the leaf surface.

Formulation
Octyl phenoxypoly ethoxy ethanol ....................................................... 50%

Benefits
• Super Spreader enhances the effectiveness of agricultural and non-crop pesticides.
• Super Spreader with glycol as the co-solvent helps maintain leaf wetness resulting in better uptake of the active ingredient.
• Glycol chemistry has less atomization and less evaporation than alcohol based surfactants.

Application Information*
1.0-2.5 L/1000 L spray solution (see product label for use rates of individual products).

Use lower rates for soft water; higher rates with hard water.

Container Size: 3.78 L

*Always read and follow product label directions and recommendations.
Crop Oil Surfactant

**XA Oil Concentrate** is a blend of light agricultural spray oil. When used, **XA Oil Concentrate** may improve activity on quackgrass, nutgrass and annual grasses such as green and yellow foxtail, and barnyard grass.

**Formulation**

Mineral Oil ................................................................................................ 83%
Surfactant blend ........................................................................................17%

**Benefits**

- Broad label application for many crops with a wide assortment of pesticides
- Excellent quality emulsion

**Application Information***

- Aatrex® 480 — 12.5 L per 1000 L
- Yuma® or Assure® II (quizalo for p-ethyl) — 5 - 10 L per 1000 L
- Basagran® — 10 L per 1000 L
- Ladder® 240 EC — 8 - 10 L per 1000 L

*Always read and follow product label directions and recommendations.
**Premium Spray Tank Decontaminator**

*All Clear®* is a highly effective all-purpose tank cleaner that is specifically formulated to remove pesticide deposits and other debris, including sticky and oily substances from tanks, hoses, booms and nozzles.

**Formulation**

Ammonia-free liquid concentrated detergent

**Benefits**

- Dual mode of action
- Removes phenoxy herbicides and trace element precipitates.
- Cleans emulsifiable concentrates, morpholine fungicides and residual herbicides.
- Can be used in all types of spray rig decontamination in the following markets: agriculture, horticulture, turf and ornamental, industrial and forestry.
- Prevents re-adhesion of herbicides to sprayer surfaces

**Application Information***

- **General Cleaning:** 2.5 L/1000 L
- **Decontamination:** 5.0 L/1000 L

Container Size: 3.78 L, 1 L

---

*Always read and follow product label directions and recommendations.*
Not All Tank Cleaners are Created Equal

*All Clear* is an innovative spray tank cleaner. Unlike other tank cleaners, *All Clear* does not depend upon a single detergent or strong solvent to remove herbicide residues lining the spray tank, hoses, pump and connecting parts. Instead, *All Clear* has a two-way action that includes a surfactant and a sequestrant. The surfactants in *All Clear* reduce the surface tension and enable it to penetrate the deposits and break them up into component parts, lifting them from the tank’s surface. The sequestering agent in *All Clear* helps to lock up materials in the washout solution. This helps to prevent re-adhesion to equipment surfaces. *All Clear attaches to and lifts off contaminants.*

Ammonia Cleaning Agent

Ammonia cleaning agent for tanks, booms, hoses and nozzles on equipment used for agricultural, commercial or lawn & garden spraying. *Flush®* does not deactivate or breakdown the pesticide. After spraying, drain and flush tank, booms and nozzles with clean water. While filling the tank with water add 500 mL Flush for every 100 L water, agitate the system and drain system completely. Rinse with a small amount of clean water and drain.

*Container Size: 10 L*
Choice Weather Master is a water conditioning agent for use with agricultural chemicals. Designed for hard water conditions, this liquid formulation locks up hard water cations allowing maximum herbicide performance. Compatible with all formulations of glyphosate, including the newer K-salts.

**Formulation**

Salts of polyacrylic, hydroxy carboxylic, propionic acids, phosphate ester and ammonium sulfate ................................................................. 50%
Constituents ineffective as spray adjuvants ........................................ 50%

**Benefits**

- Choice Weather Master reduces the effects of hard water on herbicide performance. When certain herbicide chemistries are added to water the negative charges in the herbicide molecules attract the positive ions (cations) in the water. The herbicide and these cations form a strong complex which can prevent or hinder uptake of the herbicide into the plant, effectively reducing herbicide performance.
- Multiple sequestering and chelating agents bind multiple hard water cations, such as calcium, manganese, magnesium, and iron.
- Concentrated formulation provides convenience of treating 3785 L with 10 to 20 L of liquid instead of 110-220 L of liquid ammonium sulphate.

**Application Information**

2.5-5.0 L (based on water hardness) per 1000 L of water

Add desired rate of Choice Weather Master to water before adding herbicides.

*Always read and follow product label directions and recommendations.*
**Choice Weather Master** is a sequestrant and keeps **ALL** types of hard water cations from bonding with glyphosate. **AMS only handles calcium.** Ammonium Sulfate: Hard water cations (Ca, Mg, Fe, Na, etc.) have a negative effect on glyphosate molecules. The addition of AMS allows the sulfate to bond with calcium and forms “Very Slightly Soluble” calcium sulfate, and once formed it is not likely to disassociate; however, all other cations form bonds that are “soluble” thereby allowing for disassociation and further interference with the glyphosate molecule. (Refer to chart.)

*S=Soluble (over 5,000 mg/L); SS=Slightly soluble (2,000 - 5,000 mg/L); VSS=Very Slightly Soluble (20 - 2,000 mg/L); I=Insoluble (less than 20 mg/L); X=Not a compound

From: “Water: The Universal Solvent” - Nalco Chemical Co.
Compatibility Agent for Liquid Fertilizer and Pesticide Mixtures

**E-Z Mix** is a highly concentrated compatibility agent for direct addition to liquid fertilizers when a stable mixture of pesticides and liquid fertilizer is desired.

**Formulation**

Esters of alkyl polyoxyethylene ethers .................................................. 65%
Coupling agents and other constituents ............................................... 35%

**Benefits**

- Can be used as a curative if gelling has already occurred in the spray tank
- Less agitation is required during application
- Produces a homogeneous mixture
- Allows for more accurate application rates across the entire field.

**Application Information***

**LIQUID NITROGEN FERTILIZERS:** Add 1.3 to 1.8 L per 1000 L of solution while agitating the mixture.

**MIXED LIQUID FERTILIZERS:** Add 1.3 to 2.5 L per 1000 L of solution while agitating the mixture.

*Always read and follow product label directions and recommendations.*

**Container Size:** 3.78 L
*Always read and follow product label directions and recommendations.
Antifoam/Defoamers

Fighter-F® 12.5 is a siloxane-based product designed to effectively control foam in water, oil, fertilizer and pesticide spray mixtures that can be used to knock down foam (defoam) and are also effective in preventing foam from forming (antifoam). Fighter-F 12.5 is a liquid formulation that is compatible with potassium salt formulations of glyphosate as well as most other pesticides and fertilizers.

Formulation

Dimethylpolysiloxane, polypropylene glycol and methylated silicone................................................................. 12.5%
Constituents ineffective as spray adjuvant............................... 87.5%

Benefits

• Contains a premium high concentration, dual component antifoamer, defoamer chemistry
• Antifoam prevents overflow, spillage and contamination of fill site.
• Defoamer knocks down foam quickly once it has formed in the spray tank.

Application Information*

Fighter-F 12.5 used as an Antifoam: 75 - 450 mL per 1000 L prior to mixing pesticides or fertilizers

Fighter-F 12.5 used as a Defoamer: Add as needed to break down foam produced by agitation

Keep from Freezing

Container Size: 946 mL
Concentrated anti-foaming and de-foaming agent for use with pesticide spray mixtures. Some pesticide mixtures produce foam during mixing and a small amount of Breaker added before adding pesticides will prevent foam from forming. Fill tank half full of water. Add Breaker at 7 mL/500 L. Breaker may be added after foam has formed but it will require more time for the foam to be eliminated.

**Container Size:** 175 mL

### Causes of Foam Production

1. Presence of surfactants/emulsifiers in the pesticide being used
2. Use of adjuvants containing surfactants
3. Excessive mechanical or by-pass agitation
4. Aspiration of air through leaks in circulating system.

Defoamers are used to either control foam formation or eliminate foam from forming during tank fill. This is especially important during top-filling or when aggressive agitation is involved. When the formation of foam is prevented, the product is usually referred to as antifoam. Most often, the terms defoamer and antifoam are used interchangeably.

**Fighter-F 12.5** performs both functions. The graduated cylinders below have been filled with water and glyphosate. In the bottom of each cylinder is an airstone, commonly used in aquariums. These airstones are used to simulate foaming problems that often occur during tank fill. The cylinder on the right has been treated with **Fighter-F 12.5**.
**Unique Pod Sealant to Reduce Shatter Loss**

**Pod-Stik®** is a unique latex blend, specifically developed to reduce the risk of seed shed from susceptible crops such as canola, peas and beans whose pods are prone to shatter before and during harvest. **Pod-Stik** forms a latex netting over the pod to reduce risk of shatter while allowing moisture to move freely for normal maturity development. Easy to apply, it can be either applied alone or with pre-harvest trips across the field. **Pod-Stik** should be used as part of an overall integrated strategy to reduce harvest loss.

### Formulation

- Synthetic Latex and alcohol ethoxylate .................................................55%
- Constituents ineffective as spray adjuvant ............................................45%

### Benefits

- Doesn’t slow down crop drying and has no adverse effects on maturity or quality of seed produced
- Can be used in an integrated management approach to harvest losses of shatter prone crops
- Product doesn’t translocate but sticks where it lands
- No Maximum Residue Limit

### Application Information

- Can be applied when seed pods are being filled but still pliable.
- Application rate is 0.41 L per acre
- Apply with water volumes between 15 and 20 gallons per acre.
- Higher water volumes will ensure canopy penetration and coverage to the most susceptible pods.
- Harvest should be conducted as soon as the crop is ready for an effective integrated approach to managing shatter.
- Immediately after application rinse the sprayer thoroughly with water and add **All Clear** to remove any **Pod-Stik** from the sides of the tank, pump, spray lines and nozzles.
- 1 case will do 50 acres

*Container Size: 10 L*

*Always read and follow product label directions and recommendations.*
**Superior Foam Marker**

*Trekker Trax®* is a unique blend of ingredients that produce thick-bodied, long-lasting foam. *Trekker Trax* works in nearly all water conditions regardless of hardness and mineral content or impurities.

**Formulation**

Alcohols ................................................................................................................................. 24%
Mixed anionic and non-ionic surfactants ........................................................................... 30%
Inert diluent compounds ........................................................................................................ 46%

**Benefits**

- Produces thick, long-lasting foam.
- Works with a wide range of water conditions in agriculture, commercial and industrial use.
- This easy-to-use product ensures accurate spray application and eliminates unnecessary field skips.

**Application Information***

Mix with water at approximately 1% of concentration

**In soft water:** 10 - 15 L in 1000-1500 L of water

**In medium and hard water:** 14.0 - 20.0 L in 1000-1500 L of water

*Note: If foam consistency is poor at the 2 L level, check for a malfunction or contamination in the foam generating system.*

**Container Size:** 1.89 L, 10 L

---

*Always read and follow product label directions and recommendations.*
40 *Always read and follow product label directions and recommendations.

Turf & Ornamental Products
Lake and Pond Colorant

Aquamark® Lake and Pond Colorant safely and conveniently transforms pale or off-color water into a natural appearing deep blue. Formulated as a low dust granular in a convenient solu-pak for use in contained bodies of water such as golf course water hazards, ponds, small lakes, fountains and fisheries.

Benefits

- Water Soluble Packets offer greater convienience in a pre-measured package
- New low dust formulation eliminates surface clumps and streaks associated with other powdered WSP products
- Engineered to efficiently color the water column upwards.
- Safe and non-toxic. Treated water can be used for irrigation, swimming and recreation

Application Information*

- 1 packet will treat 1 acre foot or 1234 m²
- Drop correct number of packets into the water
- Evenly spaced packets aid in quicker, more uniform coverage

Container Size: 4 x 4 x 165.85 g water soluble packets

*Always read and follow product label directions and recommendations.
**Superior Spray Dye Indicator**

*BlueTrax™ HC* is a temporary spray indicator used to show where and how spray applications have been made. This highly concentrated liquid can be used in boom, handgun and spot spraying applications.

**Formulations**

- New high concentration liquid formulation disperses rapidly
- Economical marker for all spray equipment
- Mixes with water soluble pesticides and fertilizers
- Promotes precise applications
- Indicates spray volume and drift
- Safe and non-toxic
- Washes up with soap and water

**Application Information***

<table>
<thead>
<tr>
<th>Tank Size</th>
<th>BlueTrax</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 US gallons</td>
<td>15-30 mL</td>
</tr>
<tr>
<td>15-50 US gallons</td>
<td>59-118 mL</td>
</tr>
<tr>
<td>100-200 US gallon</td>
<td>177-355 mL</td>
</tr>
<tr>
<td>Greater than 300 US gallons</td>
<td>532-710 mL</td>
</tr>
</tbody>
</table>

- For best results use flat fan spray tips when applying

*Container Size: 4 x 3.78 L; 12 x 946 mL*

---

*Always read and follow product label directions and recommendations.*
Respond® 3 is a premium wetting agent for improving water penetration and treating localized dry spot, compaction and drought stress. For use on golf courses, sports turf, etc. Available in liquid and granular formulations.

**Formulation**

**Respond 3 Liquid:** Neutral blend of polyhydroxyethyl alkoxy alkylene oxides ...................................................................................................... 100%

**Respond 3 Granular:** Neutral blend of polyhydroxyethyl alkoxy alkylene oxides .......................................................................................................... 9%

**Benefits**

- **Respond 3** provides superior penetration, excellent lateral movement and long residual with extreme turf safety.

**Application Information***

**LIQUID—Managed Application Program:** 120 mL/100 m² with two applications at 14 day intervals in early season. Use 7.5 -15 L of water. Follow up with 90 mL on a monthly basis.

**Intensive Split Dose Application Program****: Apply 180 mL/100 m² early season with 30 L of water per 100 m². Follow up with 90-180 mL as a mid season application.

**GRANULAR—Managed Application Program****: 1.5 Kg per 100 m²; 2 applications at 14 day intervals in early season followed by 1.125 Kg per 100 m² monthly as needed.

**Intensive Split Dose Application Program****: Apply 2.25 Kg per 100 m² (early season application). Follow by 1.125 - 1.5 Kg per 100 m² (mid-season application).

**Container Size:**
- **Liquid:** 9.46 L or 113 L
- **Granular:** 22.68 Kg

**Water in 0-18 hours after application**

*Always read and follow product label directions and recommendations.*
**Scent WinterGreen**

Fragrance to Mask Objectable Odors

*Scent Wintergreen* is a concentrated fragrance use to mask objectionable odours. Use *Scent Wintergreen* at a rate of 30 to 90 mL per 3.78 L of product. Stronger odours will require higher rates of fragrance. Start by adding 30 mL of *Scent Wintergreen* per 4 L and continue adding to get desired effect.

Container Size: 946 mL Bottle

*Always read and follow product label directions and recommendations.*
Reference Information
Proper Tank Mixing Procedures
When application season rolls around, the number of customer calls concerning problems with tank mixes rises. In most cases, these problems occur with the use of dry formulations. These include formulations such as Dry Flowables (DF), Water Dispersible Granules (WDG) and Wettable Powders (WP), among others.

The solution to most of the problems surrounding dry formulations involves patience, warmer temperatures and proper mixing order.

Early in the spray season, carrier (water or liquid fertilizer) temperatures are commonly lower than normal. This can also occur, even on a warm day, if the water source is a deep well or is piped a great distance underground before added to the tank. Under these conditions, it will take longer for dry formulations to dissolve. It is also important to maintain adequate agitation to ensure proper suspension of the product.

Another problem that can occur is adding dry formulations in the wrong order when tank mixing various products.

Mixing with glyphosate or glufosinate formulations
The following guidelines can be utilized throughout the season to avoid tank mixing problems:

• Fill the spray tank half full with carrier (water or fertilizer). Make sure the agitation system is engaged and working properly.

• If glyphosate (Roundup® or Touchdown®) or glufosinate (Liberty®) is being used, a water conditioning agent such as Choice Weather Master should be added first.

Continued on next page....

“An ounce of prevention is worth a pound of cure.”
- Benjamin Franklin
**WALES/DALES method**
Other pesticides should be added to the tank in this order (**WALES** or **DALES** method):

**W or D** — represents the *dry formulations* (WDG, WP, DF) and should be added to the tank first.

**A** — stands for proper *agitation*, which should be continuous and provide enough action to “roll” the surface of the carrier. Confirm that the dry products are thoroughly dissolved before adding anything else to the tank.

**L** — stands for *liquids and flowables* (L, F, S) and are added next.

**E** — stands for the *emulsifiable concentrates* (EC) and should be added next. Microencapsulated formulations should be added after the ECs.

**S** — stands for *surfactants and other adjuvants*. This includes crop oils, drift control agents, etc. Some organosilicone products can cause excessive foaming, which is another reason to add them last.

The last step is to fill the tank with the remainder of the needed carrier and continue agitation, especially if using one of the dry formulations or a product that may settle out.

**Other points to remember**
If a known compatibility problem exists, a compatibility agent, such as **E-Z Mix** is generally added before the herbicides.

If excessive foam is a problem, an anti-foaming product, such as **Breaker Fighter F 12.5**, or **Valid**, may be required. Although both products can be used as a curative, it is recommended to use preventative tactics when using a high foaming product.
### NOZZLE OUTPUTS (20 INCH NOZZLE SPACING*)

<table>
<thead>
<tr>
<th>Gal. per minute</th>
<th>.05</th>
<th>.067</th>
<th>.084</th>
<th>.101</th>
<th>.118</th>
<th>.135</th>
</tr>
</thead>
<tbody>
<tr>
<td>mL per minute</td>
<td>189</td>
<td>254</td>
<td>319</td>
<td>381</td>
<td>447</td>
<td>509</td>
</tr>
<tr>
<td><strong>6 gal per acre</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gal. per minute</td>
<td>.06</td>
<td>.081</td>
<td>.101</td>
<td>.121</td>
<td>.141</td>
<td>.162</td>
</tr>
<tr>
<td>mL per minute</td>
<td>231</td>
<td>305</td>
<td>381</td>
<td>458</td>
<td>535</td>
<td>609</td>
</tr>
<tr>
<td><strong>7 gal per acre</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gal. per minute</td>
<td>.071</td>
<td>.094</td>
<td>.118</td>
<td>.141</td>
<td>.165</td>
<td>.189</td>
</tr>
<tr>
<td>mL per minute</td>
<td>266</td>
<td>358</td>
<td>447</td>
<td>535</td>
<td>624</td>
<td>716</td>
</tr>
<tr>
<td><strong>8 gal per acre</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gal. per minute</td>
<td>.081</td>
<td>.108</td>
<td>.135</td>
<td>.162</td>
<td>.189</td>
<td>.216</td>
</tr>
<tr>
<td>mL per minute</td>
<td>305</td>
<td>408</td>
<td>509</td>
<td>612</td>
<td>713</td>
<td>816</td>
</tr>
<tr>
<td><strong>9 gal per acre</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gal. per minute</td>
<td>.091</td>
<td>.121</td>
<td>.152</td>
<td>.182</td>
<td>.212</td>
<td>.242</td>
</tr>
<tr>
<td>mL per minute</td>
<td>343</td>
<td>458</td>
<td>574</td>
<td>689</td>
<td>801</td>
<td>917</td>
</tr>
<tr>
<td><strong>10 gal per acre</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gal. per minute</td>
<td>.101</td>
<td>.135</td>
<td>.168</td>
<td>.202</td>
<td>.236</td>
<td>.269</td>
</tr>
<tr>
<td>mL per minute</td>
<td>381</td>
<td>509</td>
<td>636</td>
<td>766</td>
<td>890</td>
<td>1017</td>
</tr>
<tr>
<td><strong>15 gal per acre</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gal. per minute</td>
<td>.152</td>
<td>.202</td>
<td>.253</td>
<td>.303</td>
<td>.354</td>
<td>.404</td>
</tr>
<tr>
<td>mL per minute</td>
<td>574</td>
<td>766</td>
<td>955</td>
<td>1147</td>
<td>1137</td>
<td>1532</td>
</tr>
<tr>
<td><strong>20 gal per acre</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gal. per minute</td>
<td>.202</td>
<td>.269</td>
<td>.337</td>
<td>.404</td>
<td>.472</td>
<td>.538</td>
</tr>
<tr>
<td>mL per minute</td>
<td>766</td>
<td>1020</td>
<td>1275</td>
<td>1532</td>
<td>1780</td>
<td>2041</td>
</tr>
</tbody>
</table>

* Data also applies if every other outlet is plugged and two nozzles are used per drop, as is often the case in post-emergence herbicide application. The table may be used to:

1. Determine gallonage per acre at given ground speed and nozzle output.
2. Select proper ground speed when operating at a given nozzle pressure and output.
3. Select new nozzles when range of gal. per acre and ground speed is known.

*Note: gallons are US gallons*
AIRCRAFT CALIBRATION

Acres covered per minute

<table>
<thead>
<tr>
<th>Swath width in feet</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>4.5</td>
<td>5.2</td>
<td>6.0</td>
<td>6.7</td>
<td>7.5</td>
<td>11.2</td>
<td>15.0</td>
<td>30.0</td>
<td>45.0</td>
<td>75.0</td>
</tr>
<tr>
<td>80</td>
<td>4.8</td>
<td>5.6</td>
<td>6.4</td>
<td>7.2</td>
<td>8.0</td>
<td>12.0</td>
<td>16.0</td>
<td>32.0</td>
<td>48.0</td>
<td>80.0</td>
</tr>
<tr>
<td>85</td>
<td>5.1</td>
<td>5.9</td>
<td>6.8</td>
<td>7.6</td>
<td>8.5</td>
<td>12.7</td>
<td>17.0</td>
<td>34.0</td>
<td>51.0</td>
<td>85.0</td>
</tr>
<tr>
<td>90</td>
<td>5.4</td>
<td>6.3</td>
<td>7.2</td>
<td>8.1</td>
<td>9.0</td>
<td>13.5</td>
<td>18.0</td>
<td>36.0</td>
<td>54.0</td>
<td>90.0</td>
</tr>
<tr>
<td>95</td>
<td>5.7</td>
<td>6.6</td>
<td>7.6</td>
<td>8.5</td>
<td>9.5</td>
<td>14.2</td>
<td>19.0</td>
<td>38.0</td>
<td>57.0</td>
<td>95.0</td>
</tr>
<tr>
<td>100</td>
<td>6.0</td>
<td>7.0</td>
<td>8.0</td>
<td>9.0</td>
<td>10.0</td>
<td>15.0</td>
<td>20.0</td>
<td>40.0</td>
<td>60.0</td>
<td>100.0</td>
</tr>
<tr>
<td>110</td>
<td>6.6</td>
<td>7.7</td>
<td>8.8</td>
<td>9.9</td>
<td>11.0</td>
<td>16.5</td>
<td>22.0</td>
<td>44.0</td>
<td>66.0</td>
<td>110.0</td>
</tr>
<tr>
<td>120</td>
<td>7.2</td>
<td>8.4</td>
<td>9.6</td>
<td>10.8</td>
<td>12.0</td>
<td>18.0</td>
<td>24.0</td>
<td>48.0</td>
<td>72.0</td>
<td>120.0</td>
</tr>
<tr>
<td>130</td>
<td>7.8</td>
<td>9.1</td>
<td>10.4</td>
<td>11.7</td>
<td>13.0</td>
<td>19.5</td>
<td>26.0</td>
<td>52.0</td>
<td>78.0</td>
<td>130.0</td>
</tr>
<tr>
<td>140</td>
<td>8.4</td>
<td>9.8</td>
<td>11.2</td>
<td>12.6</td>
<td>14.0</td>
<td>21.0</td>
<td>28.0</td>
<td>56.0</td>
<td>84.0</td>
<td>140.0</td>
</tr>
<tr>
<td>150</td>
<td>9.0</td>
<td>10.5</td>
<td>12.0</td>
<td>13.5</td>
<td>15.0</td>
<td>22.5</td>
<td>30.0</td>
<td>60.0</td>
<td>90.0</td>
<td>150.0</td>
</tr>
</tbody>
</table>

The rate of application in gallons or pounds per minute is calculated by multiplying the acres per minute by the number of gallons or pounds per acre to be applied. Take for example a 100-mile-per-hour aircraft that has a 50 foot effective swath. The chart indicates that the plane has a coverage of 10.0 acres per minute. If spray is to be applied at a rate of 2 gallons per acre, the unit should be calibrated to dispense 20 gallons per minute (2 X 10 = 20). If 7.5 pounds of dry material is to be applied per acre, the unit should be calibrated to dispense 75 pounds per minute (10 X 7.5 = 75).

The basic formula for calculating acres per minute is:

\[
\text{swath width} \times 2 \times \frac{\text{miles per hour}}{1,000}
\]

COMPUTING PLANT POPULATIONS AND YIELDS

<table>
<thead>
<tr>
<th>Row Width</th>
<th>Length of Row in 1/1000 Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 inches</td>
<td>13-ft., 1-in.</td>
</tr>
<tr>
<td>38 inches</td>
<td>13-ft., 9-in.</td>
</tr>
<tr>
<td>36 inches</td>
<td>14-ft., 6-in.</td>
</tr>
<tr>
<td>30 inches</td>
<td>17-ft., 5-in.</td>
</tr>
<tr>
<td>20 inches</td>
<td>26-ft., 2-in.</td>
</tr>
<tr>
<td>15 inches</td>
<td>34-ft., 10-in.</td>
</tr>
</tbody>
</table>

Determining Plant Population*

1. Measure off 1/1000 acre row.
2. Count number of plants; then multiply by 1000 to determine plants per acre.

Determining Yields*

1. Harvest grain from 1/1000 acre row.
2. Weigh harvested grain then multiply by 1000 to get pounds of grain per acre.
3. Determine moisture content then divide pounds per acre by pounds per bushel for adjusted moisture.

* Average three or more 1/1000 acre rows for more accurate estimate of field populations and yields.

*Always read and follow product label directions and recommendations.
USEFUL MEASUREMENTS

LENGTH
1 mile = 80 chains = 8 furlongs = 1,760 yards = 5,280 ft. = 1.6 kilometers
1 chain = 22 yards = 4 rods, poles or perches = 100 links

WEIGHT
1 lb. = 16 oz. = 454 grams = 0.454 kilograms
1 short ton = 2,000 lbs.
1 metric ton = 2,204 lbs. = 1,000 kilograms

AREA
1 acre = 10 sq. chains = 4,840 sq. yards = 43,560 sq. ft. = 0.045 hectares
1 sq. mile = 640 acres = 2.59 kilometers
1 hectare = 2.471 acres

VOLUME
1 fluid oz. = 2 tablespoons = 6 teaspoons = 29.57 c.c.’s
1 liter = 1,000 c.c.’s = 0.22 Imperial gal = 2.10 pts

CAPACITIES
Cylinder-diameter² x depth x 0.785 = cubic feet
Rectangle-breadth x depth x length = cubic feet
Cubic Feet x 7.5 = gal

QUICK CONVERSIONS
1 pt. / acre = 1 fluid oz. / 302 sq. yards
1 gal. / acre = 1 pt. / 605 sq. yards
1 lb. / acre = 1 oz. / 302 sq. yards
1 cwt. / acre = 0.33 oz. / sq. yard
1 mph = 88 ft. / minute
3 mph = 1 chain / 15 sec.
1 liter / hectare = 0.089 gal. / acre
1 kilogram / hectare = 0.892 lb. / acre
1 c.c. / 100 liter = 0.16 fl. oz. / 100 gal
125 c.c. / 100 liter = 1 pt. / 100 gal
1 gm. / 100 liter = 0.16 oz. / 100 gal

A strip 3 ft. wide x 220 chains = 1 acre
A strip 4 ft. wide x 165 chains = 1 acre
A strip 5 ft. wide x 132 chains = 1 acre

*Always read and follow product label directions and recommendations.*
CONVERSION TABLE

1 kilogram (kg) = 1000 grams (g) = 2.2 lbs.
1 gram (g) = 1000 milligrams (mg) = .035 ounce
1 liter = 1000 milliliters (mL) or cubic centimeters (cc)
   = 1.058 quarts
1 milliliter or cubic centimeter = .034 fluid ounce
1 milliliter or cubic centimeter of water weighs 1 gram
1 liter of water weighs 1 kilogram

1 lb. = 453.6 grams
1 ounce = 28.35 grams
1 pt. of water weighs approximately 1 lb.
1 gallon of water weighs approximately 8.34 lbs

1 gallon = 4 quarts = 3.785 liters
1 qt = 2 pts = .946 liters
1 pt = .473 liters
1 fluid ounce = 29.6 milliliters or cubic centimeters

QUICK CONVERSIONS

<table>
<thead>
<tr>
<th>Temperature °C</th>
<th>°F</th>
<th>Length cm</th>
<th>inch</th>
<th>Volume liters</th>
<th>quarts</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>212</td>
<td>2.5</td>
<td>1</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>90</td>
<td>194</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>80</td>
<td>176</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>3.2</td>
</tr>
<tr>
<td>70</td>
<td>158</td>
<td>20</td>
<td>8</td>
<td>4</td>
<td>4.2</td>
</tr>
<tr>
<td>60</td>
<td>140</td>
<td>30</td>
<td>12</td>
<td>5</td>
<td>5.3</td>
</tr>
<tr>
<td>50</td>
<td>122</td>
<td>40</td>
<td>16</td>
<td>6</td>
<td>6.3</td>
</tr>
<tr>
<td>40</td>
<td>104</td>
<td>50</td>
<td>20</td>
<td>7</td>
<td>7.4</td>
</tr>
<tr>
<td>35</td>
<td>95</td>
<td>60</td>
<td>24</td>
<td>8</td>
<td>8.5</td>
</tr>
<tr>
<td>30</td>
<td>86</td>
<td>70</td>
<td>28</td>
<td>9</td>
<td>9.5</td>
</tr>
<tr>
<td>25</td>
<td>77</td>
<td>80</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>68</td>
<td>90</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>59</td>
<td>100</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>200</td>
<td>79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>32</td>
<td></td>
<td>feet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-5</td>
<td>23</td>
<td>300</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>14</td>
<td>400</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15</td>
<td>5</td>
<td>500</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20</td>
<td>-4</td>
<td>1000</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-25</td>
<td>-13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-30</td>
<td>-22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-40</td>
<td>-40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Always read and follow product label directions and recommendations.*