Increasing Lipophilic Character

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Product Manager – Western US

What are we really talking about?

Making your herbicide applications work better…..

- Post emergent broadleaf & brush applications.
- Things you already know, but should be reminded of.

Short History of 2,4-D

- Invented in 1945 by British for destroying enemy food source.
- First commercially sold in 1946.
- First selective herbicide to target Dicots (Broadleafs)
- Basic mode of action works like cancer to the plant – disrupts growth hormones so plant grows uncontrollably resulting in collapse of structure.
- Manufactured by Monsanto & Dow in early years.
- Worlds 5th most used herbicide today.

Other Products Invented in 40's

The Slinky

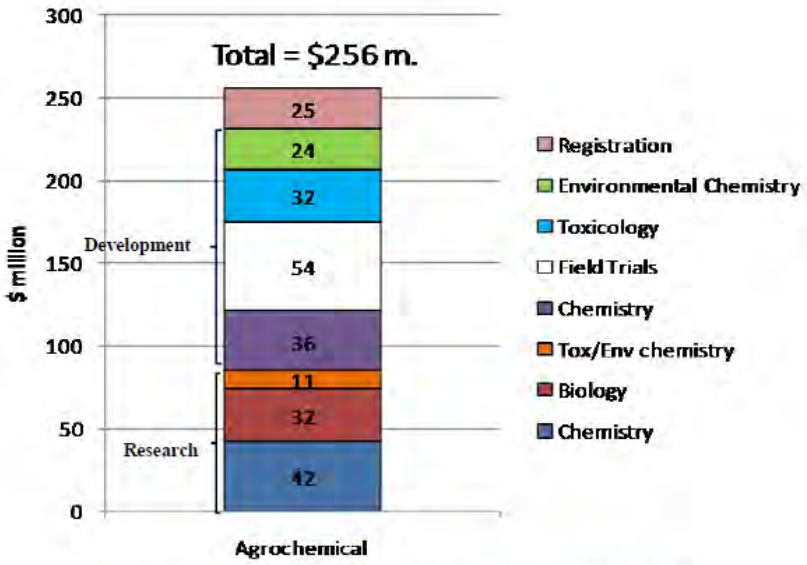
The Ball Point Pen

The Microwave Oven

The Challenge:

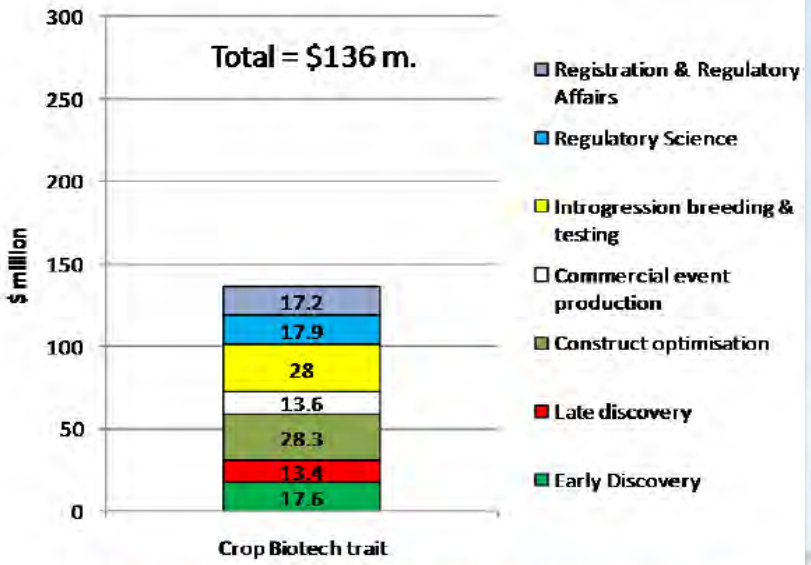
Cost of Bringing a New Product to Market

Agrochemical



Agrochemical costs based on 2009 Crop Life America/ECPA study

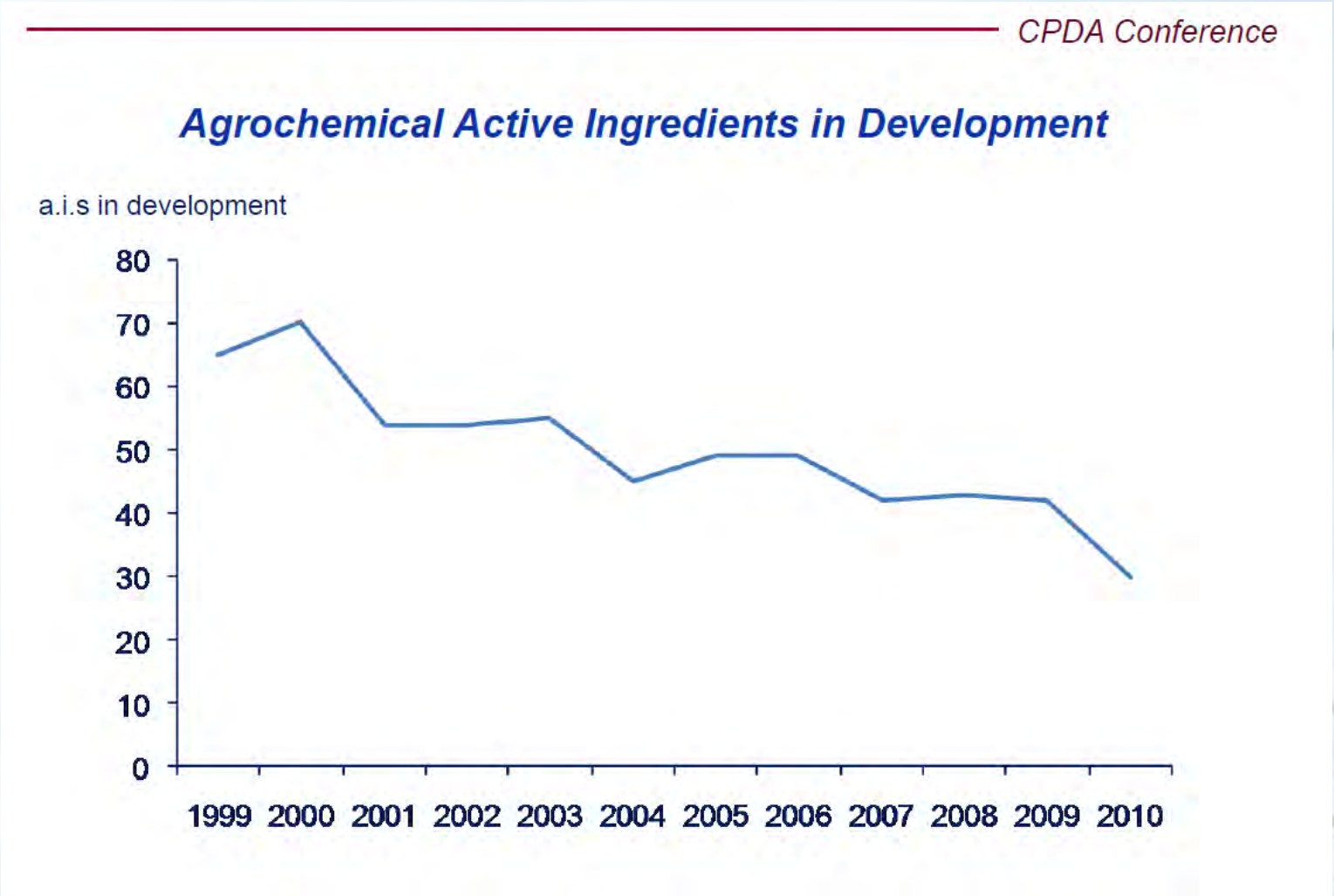
Plant biotechnology trait



Plant biotechnology trait costs based on 2011 Crop Life International study

HELENA®

The Limitations:



Back To The Future:

Forms of 2,4-D?

Amine

- High water solubility.
- Low solubility in oils & waxes.
- Slow absorption into plant leaves.
- Low volatility.
- Does not mix well with Liquid N.
- Low probability of crop injury when temperature exceeds 85 degrees.

Ester

- Low water solubility.
- High solubility in oils & waxes.
- Quick absorption into plant leaves.
- High volatility.
- Mixes easily with Liquid N.
- High probability of crop injury when temperatures exceed 85 degrees.

Welcome Free Acid Technology!

- Introduced in 2000 – (15 years old)
- It took 55 years to create this technology!
- 66% to 88% more potent than Ester or Amine form
- 50% AI needed to produce = results to old 2,4-D
- Low Volatility
- Low Odor
- Speedy Absorption
- Unique to Helena Chemical **only**!
- Making the 3rd form of 2,4-D
  - Amine, Ester & Free Acid

Enhanced Efficacy Herbicide Formulations – *"Working"* Definition

- Herbicide formulations that are designed to improve the activity of the active ingredient and/or correct spray application problems
- Also referred to as "in-can" adjuvants, co-formulants, and "loaded" formulations (half loaded / fully loaded etc)

Advantages of Enhanced Efficacy Herbicide Formulations

- Eliminates or supplements need for tank-side adjuvants
- Assures adjuvant inclusion
- Reduces the chance for using incorrect adjuvants or rates
- ***Regulatory simplicity*** (eliminates need for separate adjuvant registrations)

Herbicide Products With Enhanced Efficacy Formulations - Basics

Enlist™ Weed Control System

VASTLAN™

SELECTMAX® HERBICIDE WITH INSIDE TECHNOLOGY™

Engenia™ Herbicide

ARSENAL® POWERLine® herbicide

Vista® XRT SPECIALTY HERBICIDE

Garlon® 4 Ultra SPECIALTY HERBICIDE

Roundup® PRO Herbicide by Monsanto

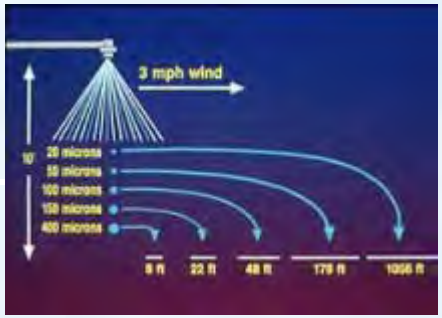
OneStep® herbicide

Functions Provided by Commercial EE Pesticides

• SELECT MAX	MSO Ester + NIS
• POAST PLUS	MSO ester + buffer
• **GARLON 4 ULTRA**	**MSO solvent / adjuvant**
• ENLIST (2,4-D)	Drift reduction agent
• ENGENIA (dicamba)	Volatility reduction aid
• EXTEND MAX	Volatility reduction aid
• **VASTLAN**	**Eye irritation modifier**
• **VISTA XRT**	**MSO Solvent / adjuvant**

Enhanced Efficacy Herbicide Chemistry Options

Modifying A.I. for Absorption Enhancement (Ester form)	Modifying A.I. Absorption Enhancement (Acid form)	Modifying A.I. For Volatility / Drift reduction (Salt Forms)	Modifying A.I. for reducing Eye Irritation / damage (Mild pH Salt forms)



BATTLESHIP III

TRYCERA

Engenia Herbicide

Enlist

Outlaw

ON DECK

Opti-Amine

Brush-Rhap

HardBall

VASTLAN™
(Choline Salt)
2,4-D & Triclopyr

PLAN FOR SUCCESS

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Enhanced Efficacy Herbicide Formulation Options ("Loaded")

SURFACANTS Coverage Enhancement & Retention	SOLVENTS Efficacy Enhancing Oils (MSO, Mineral)	ABSORPTION ENHANCEMENT (Specialized Surfactants)	SPRAY MIX UTILITY Drift / Deposition, Volatility Reduction
			
MSMA (all)	TAPOUT Garlon 4 Ultra SPECIALTY HERBICIDE	"Loaded Glyphosate" Roundup POWERMAX	Enlist Engenia Herbicide
ENDRUN			

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Helena Enhanced Herbicide Efficacy Formulation Product Development *Strategy:*

"Increase active ingredient *lipophilic* character"

Why More Lipophilicity????

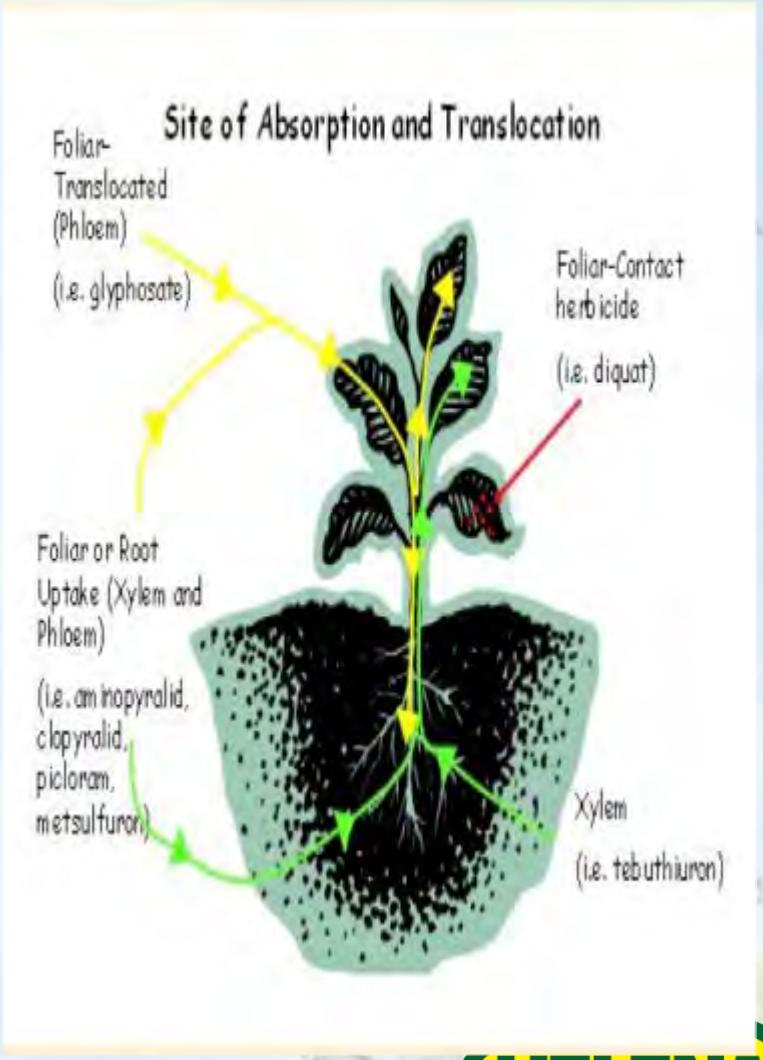
- Plant surfaces are **lipophilic (oil loving)**
- Water based spray applications are **lipophobic (oil hating)**
- Water based sprays are “repelled” by lipohilic plant surfaces
- Absorption of actives is poor and slow

Pathways for Enhancing Auxin Herbicide Absorption

1. Free acid form is more lipophilic = > movement through wax surface
2. Minimizing the anionic charge reduces repulsion from anionic plant surfaces

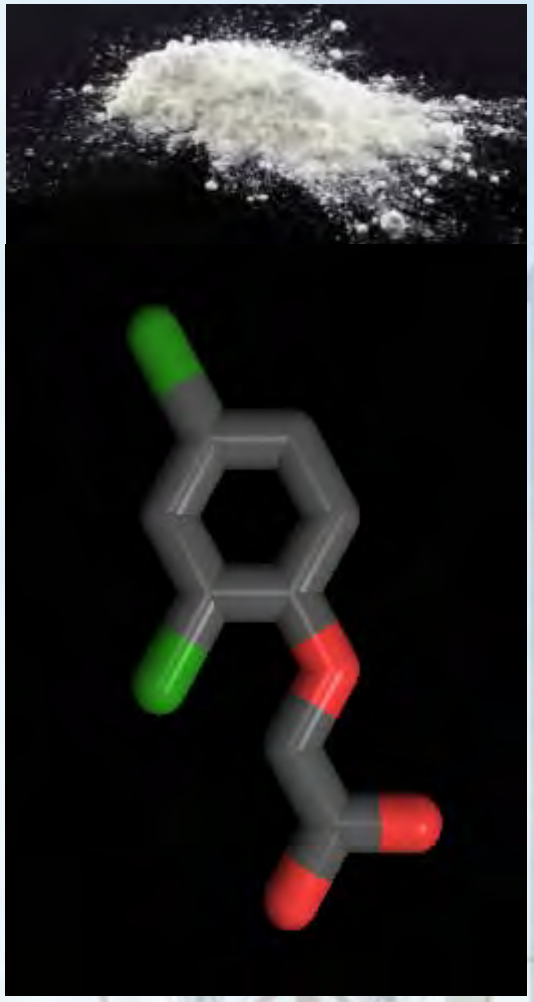
   (pH reduction)

1. Maintaining spray deposit moisture



Auxin Herbicide Acids: > Lipophilic character =

- > Degree & rate of absorption
- > Resistance to wash-off
- > Compatibility
- > Activity in cool temps
- > Resistance to leaching
- > Tolerance to water quality



Back to the story!

2,4-D Acid

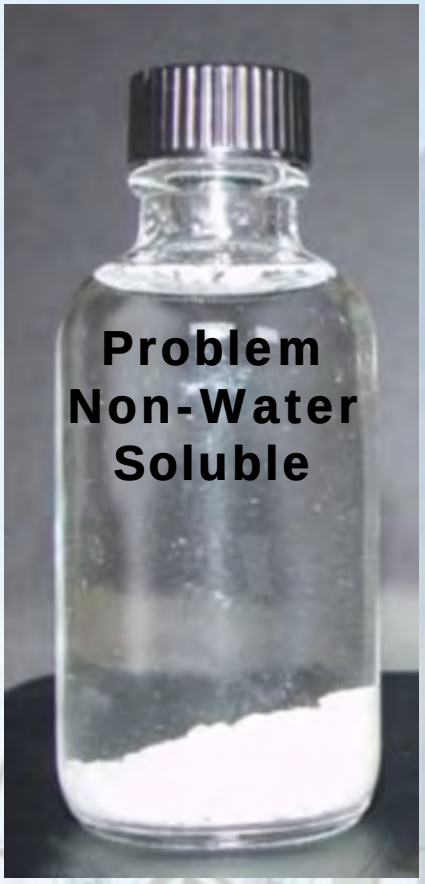
Surfactants

SS Technology

HardBall

Herbicide Acid *Limitation!*

WATER INSOLUBLE



Insolubility limits formulation choices, reduces efficacy and increases application problems

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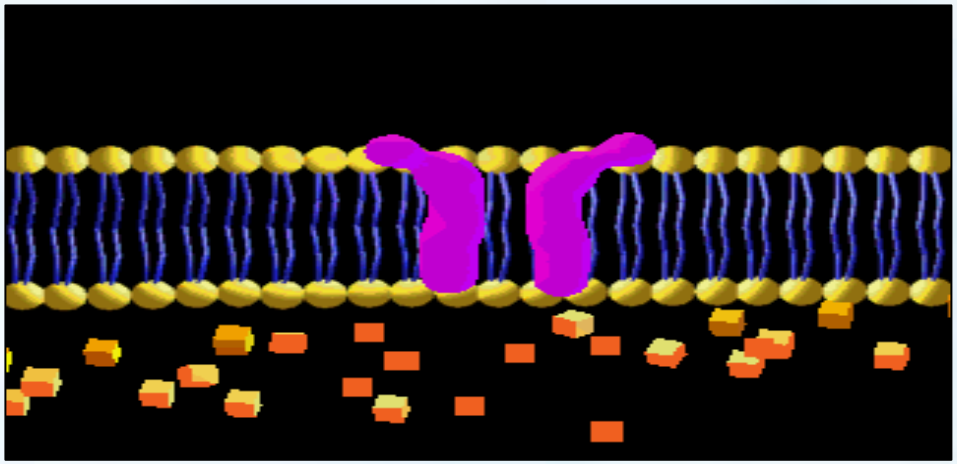
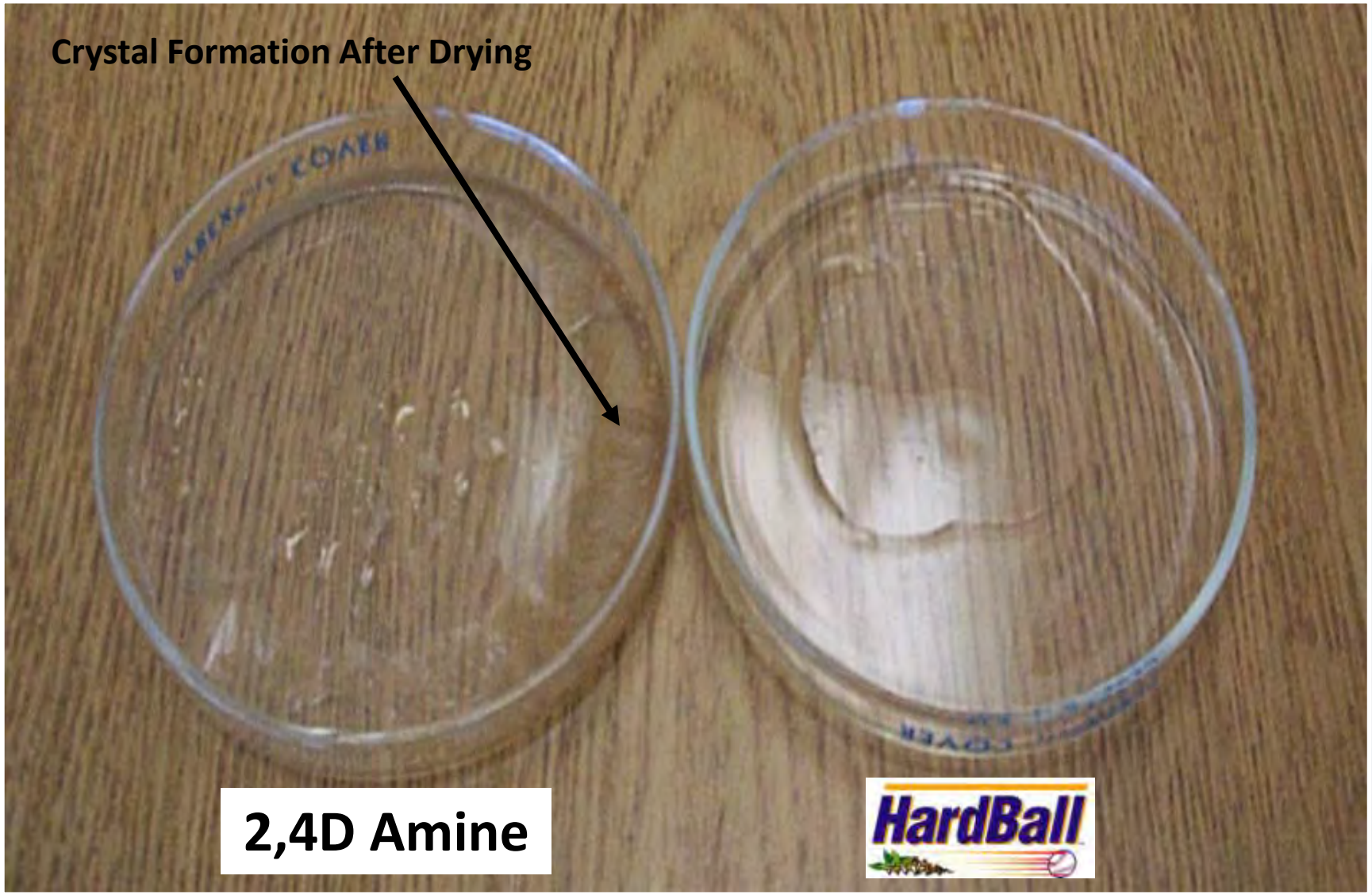
Spray deposit moisture required for absorption

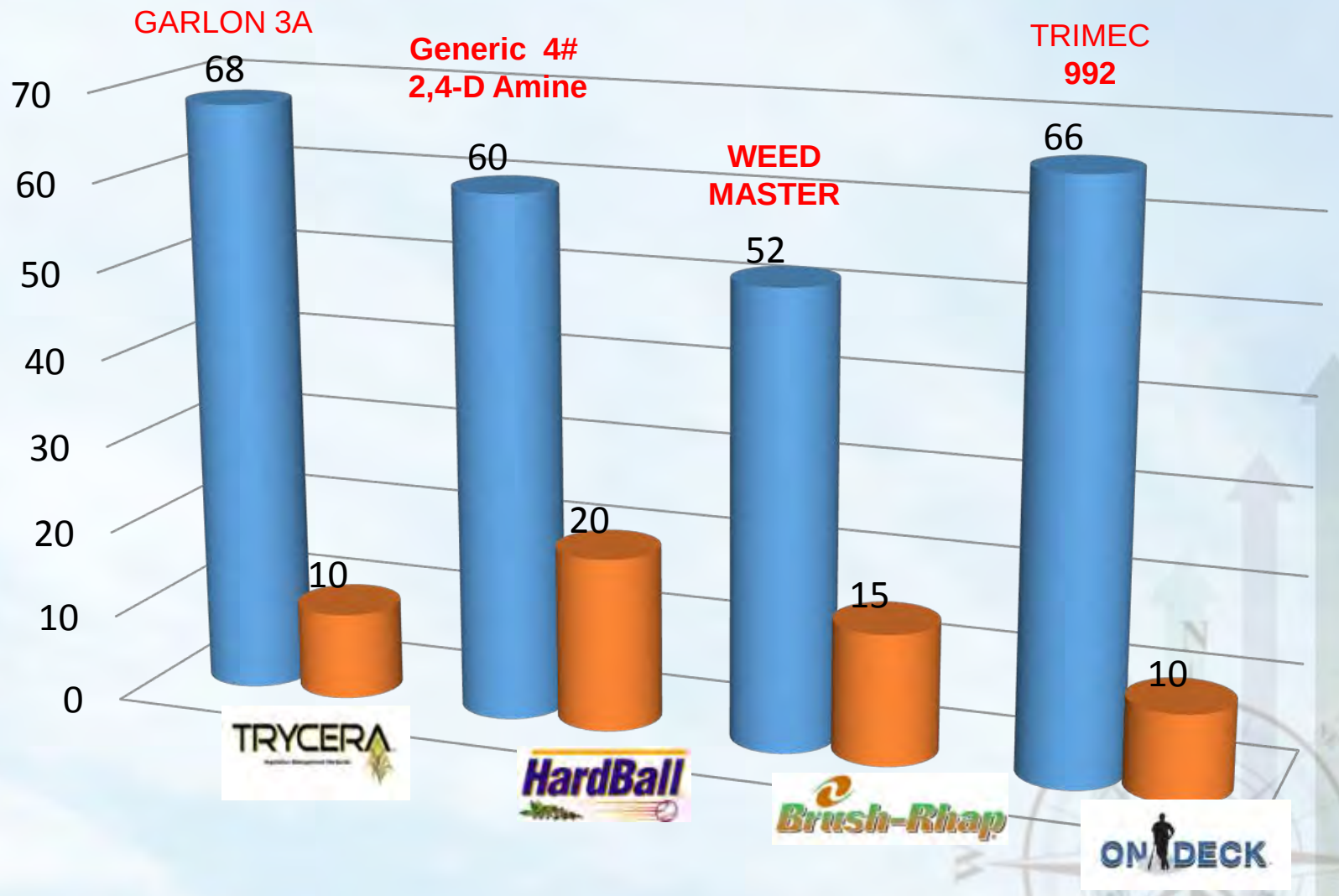
Actives move from where they are Concentrated
to where they are not by ***DIFFUSION***



Evaporation from the spray deposit and/or crystallization of active reduces diffusion which results in lower rate & speed of absorption


Crystal Formation After Drying
2,4D Amine
HardBall

Comparison of Non-Functional Ingredient Loading



Non-Functional Ingredients = Water, salts, emulsifiers, esters

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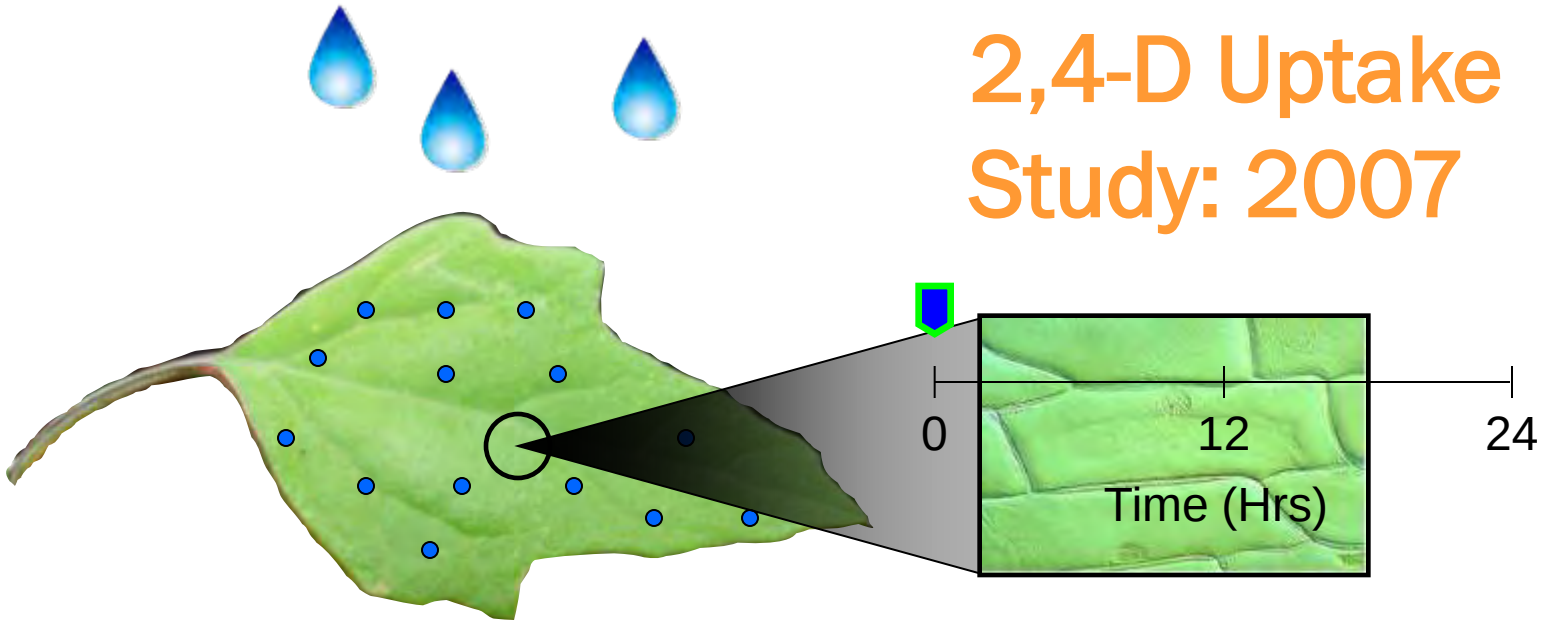
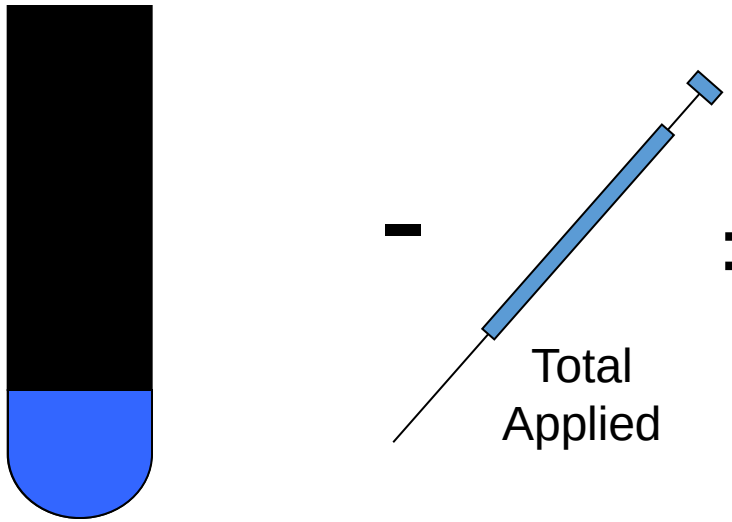
2,4-D Uptake Study: 2007





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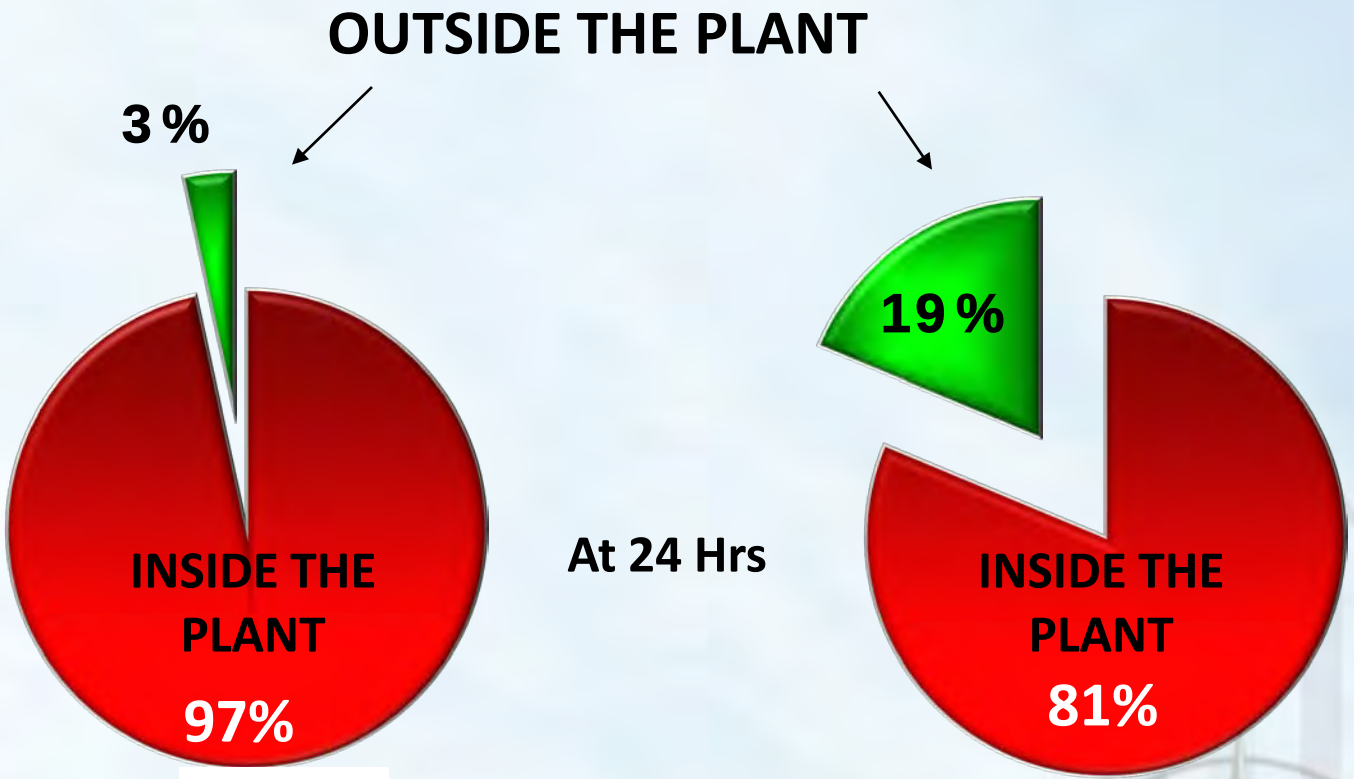
Total Applied

=

Amount in the plant

Radio-Labeled Uptake



2,4-D Acid Formulation
1 Quart/Acre

Amine Salt
1 Quart/Acre +
0.2% Surfactant

Conducted by: J. A. Zabkiewicz, Ph.D. - PPCNZ (2007)

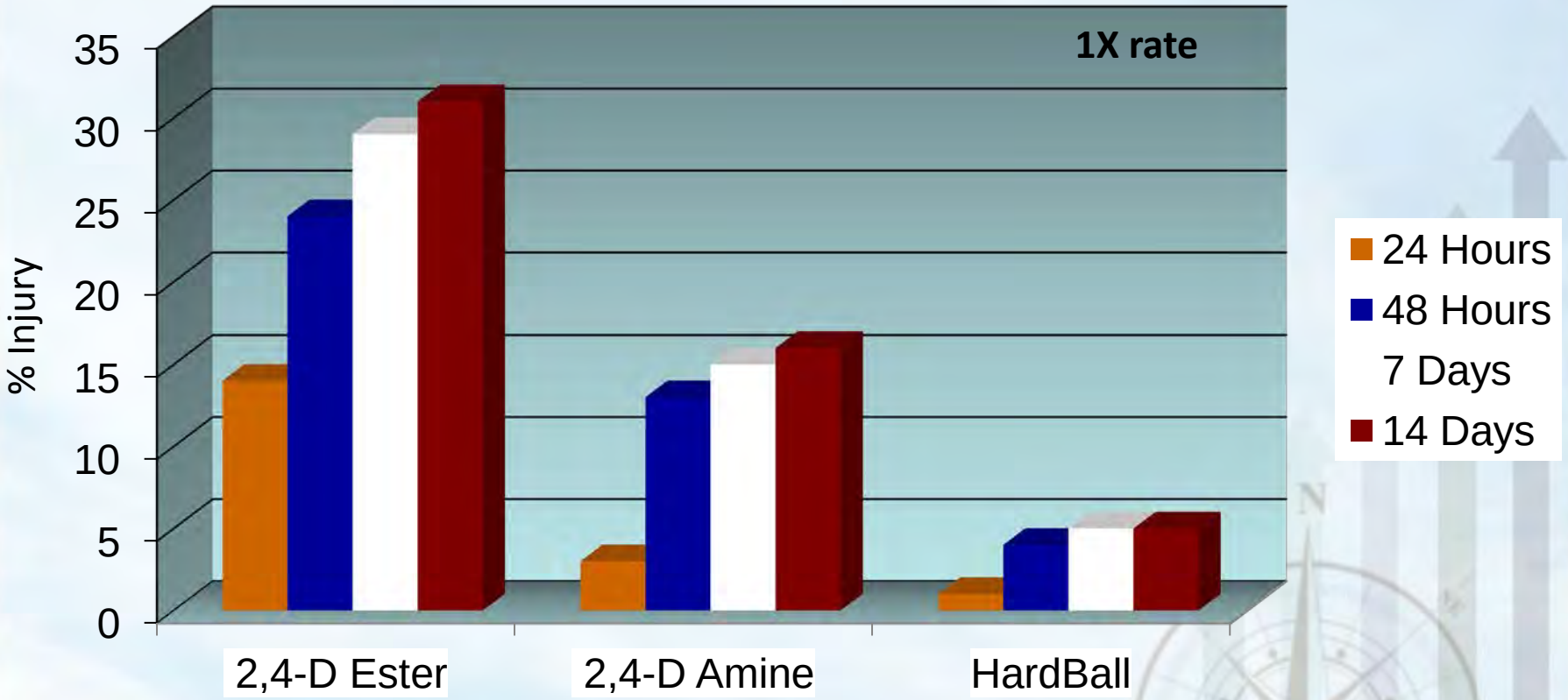
Volatility

Dead Plant is bad in this study!

***HardBall* @ 96 Hrs**

Generic Ester @ 96 Hrs

Field Volatility Trial



Plot Information:
Trial Conducted by: Dr. Jim Griffin – LSU AgCenter
Year: 2010 and 2011
Crop: Tomatoes
Location: Baton Rouge, LA

Application Information:
Treatments: Applied at (1 lb ae)
Ester - 34 oz product /A
Amine - 34 oz product /A
HardBall - 74 oz product /A

PLAN FOR SUCCESS

Increasing Lipophilicity allows us to get more with less!

Basic	Less Active on the ground	Helena
2,4-D LV6 3# ae/acre @ 64 oz/acre	2,4-D **66% reduction in AI**	HardBall 1# ae/acre @ 64 oz/acre
Garlon 4 2# ae/acre @ 64 oz/acre	Triclopyr **29% reduction in AI**	TRYCERA 1.43# ae/acre @ 64 oz/acre
Weedmaster 1.93# ae/acre @ 64 oz/acre	2,4-D & Dicamba **46% reduction in AI**	Brush-Rhap 1.05# ae/acre @ 32 oz/acre
E-2 2# ae/acre @ 64 oz/acre	2,4-D, Fluroxypyr **38% reduction in AI**	Trump Card 1.24# ae/acre @ 48 oz/acre
Banvel 1# ae/acre @ 32 oz/acre	Dicamba **29% reduction in AI**	VISION .71# ae/acre @ 24 oz/Acre
Trimec 992 1.6# ae/acre @ 64 oz/acre	2,4-D, Dicamba, MCPP **48% reduction in AI**	ON DECK .84# ae/acre @ 32 oz/acre

Other EE Formulations:

Velossa - Hexazinone

- Alcohol free formulation
- 21% more AI per gallon
- 300 times less evaporation than Velpar L
- Non-flammable
- Low freeze point

All because we have <u>Enhanced Efficiency</u> with an adjuvant package.

VELOSSA

VELPAR L	VELOSSA
Flammable Liquid	Non-flammable Liquid
Flammable liquid shipping classification required	No hazardous shipping classifications are required
DANGER Signal Word (eyes)	DANGER Signal Word (eyes)
Store above 32 F	Non-freezing down to 5^{0} F
Poor reconstitution after freezing	Reconstitutes after freezing
Non-corrosive	Non-corrosive
Alcohol based formulation	Alcohol free formulation
Evaporation rate: 1.70	Evaporation rate: .005 (300 times less than VELPAR L)
2.0# / Gallon active	2.43 lbs / Gallon (21% more active per oz than VELPAR L)

The future for Helena & EE Tech:

- Higher Load of AI
  - More pounds in a gallon = lower use rates
  - Second Generation Tech
- More AI offerings
  - Pre-generic products
  - Alternative AI combos
- Signal Word designation to Caution
  - Changing Adjuvant packages to limit eye danger
  - Changing Adjuvant packages to allow aquatic use

What does this mean to you?

- New AI's are going to be less common.
- Old AI's are have been or are going to be re-engineered.
- Creating an "oil like" solution is imperative to increased herbicide efficiency.
- Acid Chemistry is here to stay and gives you more options:
  - Decreased Volatility
  - Decreased AI into environment
  - Decreased Odor
  - Increased Efficiency from decreased herbicide crystallization
  - Increased Lipophilicity
  - Continuous improvement

What does this really mean to you?

Do you pay more in the end for Enhanced Efficiency?

Yes & No

- You can pull the adjuvant from your mix.
- You can reduce your rate and keep result the same.
- Do the math (**more per gallon – <u>less per Acre</u>**)
- Does your site dictate a need for EE?
- Do we have an obligation to reduce AI being environmental stewards?
- How do you determine efficiency?

Questions

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