Formulation and Delivery of Actives: Technology Promises Delivered and Renewed

Scott Hutchins and Ray Boucher

*Dow AgroSciences*

9330 Zionsville Road
Indianapolis, Indiana
Outline of Topics

- Premise of IPM
- Formulation Science and Technology
  - Definitions & Formulation Design Considerations
  - “Older” vs. “Newer” Formulation Technologies
- Delivery Systems
- Future Innovation Space
- The role of technology in IPM
Premise of IPM

- PEST MANAGEMENT IS all about using technology to reduce pest-induced injury

- INTEGRATED PEST MANAGEMENT IS all about the rational and cost-effective use of technology

- IPM does/should NOT advocate avoidance of technology

- The future Promise of IPM is BETTER TECHNOLOGY !!
Definitions

- Active Ingredient – any substance that will prevent, destroy, repel or mitigate any pest or that functions as a plant regulator, desiccant or defoliant

- Formulation – the active ingredient combined with co-formulants to create a product with good handling, efficacy and stability properties

- Co-formulant – any substance other than the active ingredient that is intentionally added to a pesticide product

- Delivery System – the formulation, package and application equipment
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Formulation Design

Market Place Drivers

Formulation Parameters

Formulation Design

Biological Parameters
Market Place Drivers

• Cost
  – Economical control of pest
  – Gross Margin to the Company

• Handling Properties
  – Ease of use – liquids generally preferred
  – Safety – protective equipment required by user

• Tank mix compatible with other formulations

• Application equipment compatible
Formulation Parameters

- Active Ingredient physical properties drive the formulation type selection process
  - Low melt point – dry product difficult, liquid product preferred
  - High melt point, low solubility – dry product
  - High melt point, good solubility – liquid or dry product possible
- Choice based on efficacy, customer needs
Biological Parameters

<table>
<thead>
<tr>
<th></th>
<th>Herbicide A applied at 512 g/ha</th>
<th>% Control 19 Days after Application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ivyleaf Morningglory</td>
<td>Velvetleaf</td>
</tr>
<tr>
<td>EC</td>
<td>63%</td>
<td>100%</td>
</tr>
<tr>
<td>Dry Flowable</td>
<td>40%</td>
<td>80%</td>
</tr>
</tbody>
</table>

- Conclusion – 25-50% more active required to achieve same level of pest control
Older vs. Newer Technologies

- **Older Formulation Technologies:**
  - Emulsifiable Concentrates, Soluble Liquids, Wettable Powders

- **Older Co-Formulants:**
  - Nonyl phenol ethoxylates (NPE), toluene, xylene, chlorinated solvents

- **Implications and Issues:**
  - Worker exposure to co-formulants with potential toxicology issues
  - Environmental exposure to co-formulants with potential issues
Older vs. Newer Technologies

• Newer Formulation Technologies:
  – Capsule Suspensions, Suspo emulsions, Invert emulsions

• Newer Co-Formulants:
  – New surfactant chemistries, biodegradable solvents, natural materials

• Implications and Benefits:
  – Less worker and environmental exposure to toxic co-formulants
  – Improved efficacy, flexibility and handling properties
Older vs. Newer: Case Studies

Chlorpyrifos Formulations:

LD$_{50}$(rat) mg/Kg:

Chlorpyrifos CS  >5000

Chlorpyrifos EC 350
Older vs. Newer: Case Studies

Glyphosate Formulations:

Original DAS Formulation
• Rainbow Trout LD50 >200 mg/L
• Green Algae LD50 >100 mg/L
• Daphnia EC50 >200 mg/L

New DAS Formulation
• Rainbow Trout LD50 <100 mg/L
• Green Algae LD50 < 1.0 mg/L
• Daphnia EC50 < 100 mg/L
Delivery Systems: Baits

• **Past:**
  – Cost Driven, Reduced Efficacy, Broad Spectrum Toxicant, Poor Selectivity

• **Innovations:**
  – Use of attractants
  – Sprayable Bait Formulations
  – Increased spectrum

• **Result:**
  – Efficacy equal or better than commercial standards
  – Selectivity Controlled (non-target species considered)
  – Food Chain Friendly
  – Integral component of IPM system
Delivery Systems: Case Study

Fruit Fly Control:

Cover Spray - Malathion (500 g/acre)
Protein + Malathion (5 g/acre)

GF-120*NF (Spinosad 0.4g/acre)
• Organic, Safe to Beneficials, Safe to Cars!
Delivery Systems: Drift Control

• Past:
  – Drift Agents managed as tank mix additives, Nozzle Configuration driven by efficacy only, General solutions

• Innovations
  – Use of Wind Tunnels for Experimental Design
  – Emphasis on entire tank mixture
  – In-the-can Formulations

• Result:
  – Registrants increasingly engaged in spray drift
  – Efficacy/Spray Drift optimized
  – More specific labeling and/or built in drift control
Delivery Systems: Case Study

Non-Target Drift Control:

Drift is Significantly Reduced via Reduction in % of Small Droplets
Delivery Systems: Seed Coatings

• Past:
  – Seed Protection, Stand Improvement

• Innovations
  – Improved Coating Techniques
  – Discovery Goals Targeting Seed

• Result:
  – Seed is an ideal delivery system
  – Systemic insecticides/fungicides will be selected based on this characteristic
  – Coating technologies will open up new concepts
Delivery Systems: Case Study

Fungicidal Protection via Seed Coating:

(Older System)

(Newer System)
Future Innovation Space

- Remote Sensing and Pest Detection
  - Sentricon™ ESP Remote Sensing

- Precise selection and mixing of actives
  - On-Demand Creation of specific products
    (combination of required actives in preferred formulation)

- Use of Chemical Taxis techniques
  - Attractants/Repellants matched with real actives
Older vs. Newer Technologies

• The future Promise of IPM:

  BETTER TECHNOLOGY through Innovation!!
  – New Preventive Technologies
  – New Curative Technologies
  AND

  ADVANCED FORMULATIONS
  NOVEL / TARGETED DELIVERY SYSTEMS

The IPM Community must be … “Obsessed with Progress”
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