CULTIVATING *EXCELLENCE*

Unlocking the Power of Your Biological Active Ingredients Through Formulation Technology

ABIM - Basel
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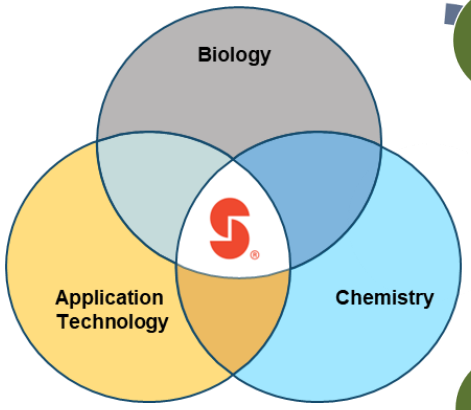
Stepan®
Agricultural Solutions

Stepan Biocontrol Formulation Development Capabilities



OMRI / NOP Co-formulants
Emulsifiers, solvents, dispersants, adjuvants

Large Formulation Database
OD, SC, SE, EC, SL, EW, WP, WG

Expertise and Innovation
BSL2 lab for Biological studies

Fermentation Platform
Biosurfactants, Biologicals

- Global supplier focused on partnering with companies across the crop protection and plant nutrition industry for over 50 years
- Company focus on co-formulants/adjuvants/inerts, associated formulation technology, and development services
- Diverse product portfolio of products including OMRI-listed and NOP-approved formulation ingredients
- Diverse ways for working together based on customer needs
- Additional internal capabilities/expertise includes microbiology, analytical chemistry, fermentation, application testing, and agronomy

Global Solutions Provider with a Local Footprint

Stepan's Global Technology Center – Northfield, IL, USA
- New Product Development
- Biotechnology and Sustainability
- Microbiology Labs, BSL-2
- Coformulant Customization
- Formulation Innovation

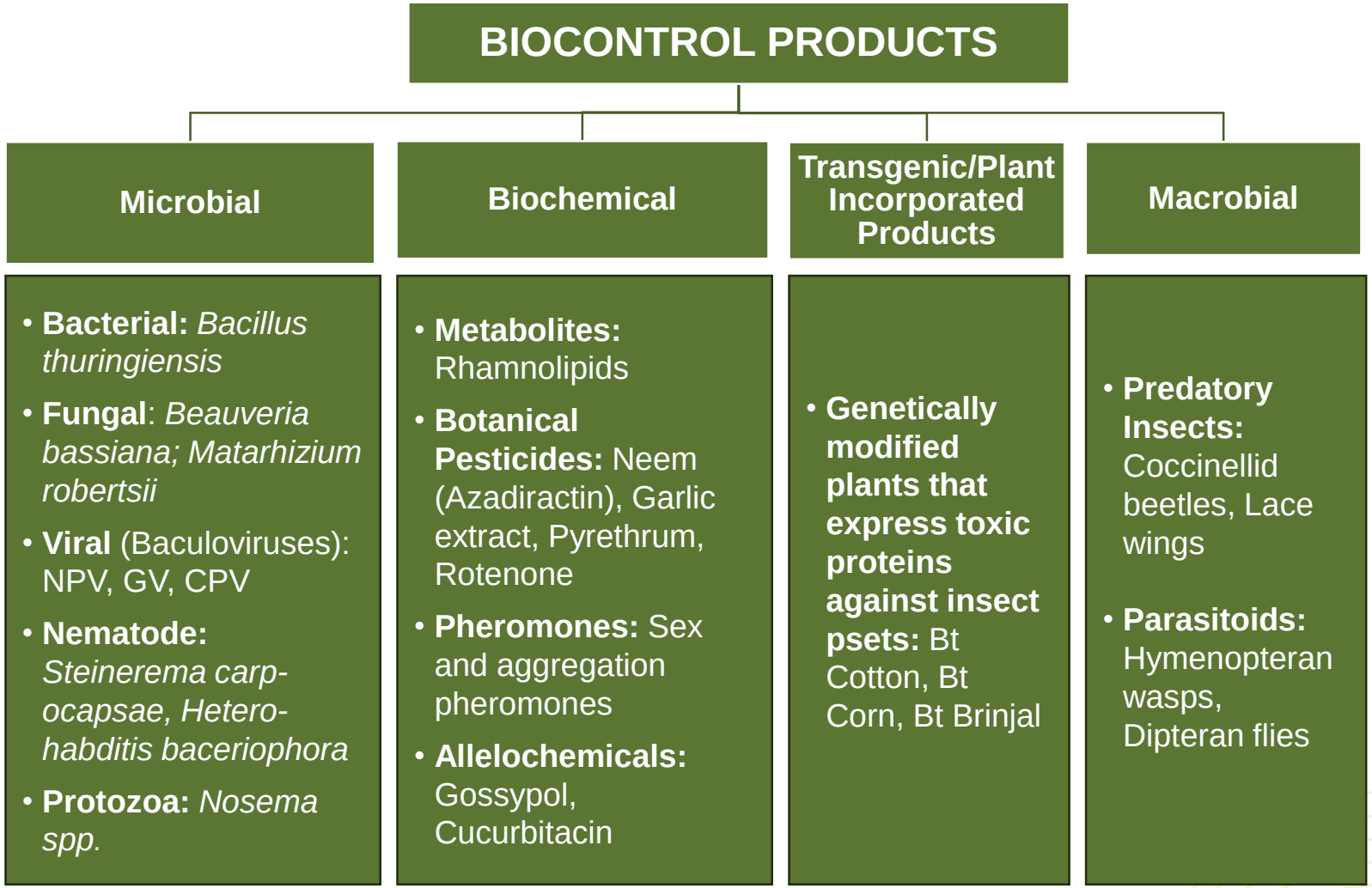
Agricultural Innovation Center – Winder, GA, USA
- Greenhouse and Agronomy
- Wet and Dry Formulation
- Technical Transfer Support
- BSL-2 Formulation Lab

Stepan Europe Headquaters – Voreppe, FR, EU
- Polymeric Dispersants Center of Excellence
- Liquid and Dry Formulation Capabilities

Fermentation Technology & Production Facility – Lake Providence, LA, USA
- Production Vessel Capacity of >430k Gallons
- Partnering with Customers for Fermentation Production

Introduction to Biocontrol Products

Global Solutions Provider with a Local Footprint



- Biocontrol products broadly defined to include Microbials, Biochemicals, Transgenic Products, and Macrobials
- Organic farming practices additionally include the use of inorganics (i.e. Cu, S)
- Formulation of microbials affords distinct challenges based on the unique nature of organisms
- Matching of the properties of the microbial or biochemical with formulation type is central to creating a viable commercial product

Preferred Biological Formulations

Oil Dispersions (OD)

Active

(Microorganisms)

dispersed in an oily carrier

Emulsifiable Concentrates (EC)

Active

(Essential oils)

diluted into an organic solvent

Suspension Concentrates (SC)

Active

(Spores, Sulfur, Copper)

suspended in water

Wettable Granules (WG)

Active

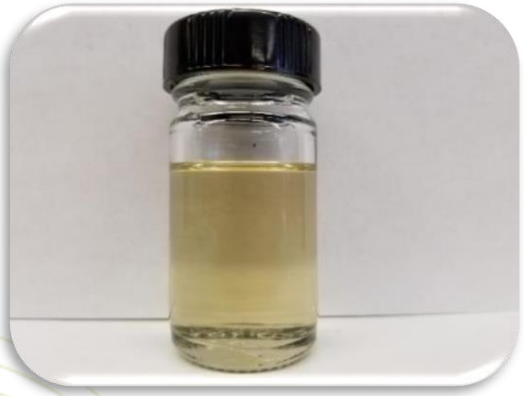
(Sulfur, Copper,

Microorganisms)

in dry form

Benefits of formulating:

- Better homogeneity
- Longer shelf-life
- Higher efficacy
- Easier to handle
- Combo with conventional AIs

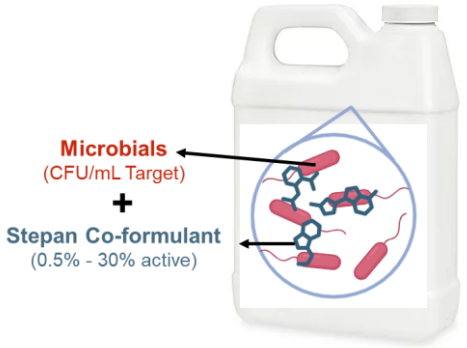


Formulation Technology is Critical for Unlocking the Potential of Microbial Pesticides

Establishing Biopesticide Formulators Toolbox - Diverse Organisms Require Diverse Solutions

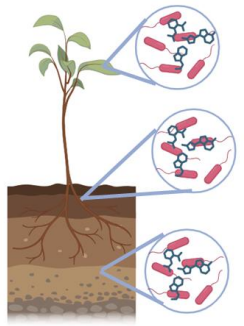
Microbials

Formulated Product



Tank Mix or Equivalent

Application



Biocontrol → Application → Formulation → Co-formulants → End Product

Microbial	Application	Formulation	Co-formulants	End Product
Microbial Active Concentration	Foliar/Soil/Seed Applied Precision Technology Conventional Sprayer Field	Liquid or Dry Aqueous or Solvent-Based Solution vs Dispersion Additives: Co-formulants, Filler - Tank Adjuvant	OMRI/NOP Regional Inventories Classification Biocompatibility	Efficacy Formulation stability Formulation Shelf life

Oil Dispersions With Microorganisms

Why OD?

Water-free
No need of preservatives
Microorganism shelf-life improved
Liquid → Handling ease
- Safer

Challenges

Physical stability over time
Difficult to formulate
Restricted OMRI list

OD typical composition

Microorganisms	5 - 50 %	
Oil	60 - 90	Carrier
Emulsifiers	5 - 20	Enables homogeneity upon dilution
Dispersants	2 - 10	Prevents sedimentation and aggregation
Wetting Agents	1 - 3	Improves microorganism coverage
Adjuvant	1 - 5	Improves spreading
Rheology Aid	0.5 - 3	Improves physical stability
Antifoam	~ 0.1	Limits foam

Biopesticide

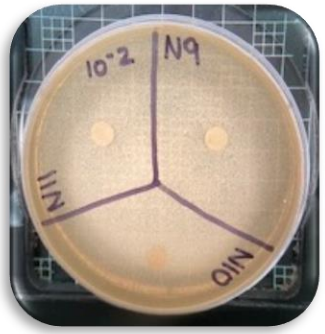
Choosing the right co-formulants for the right performance

MAKON UD-8 Adjuvant Boosts Efficacy

Adjuvants and formulation science increase the performances of pesticide efficacy

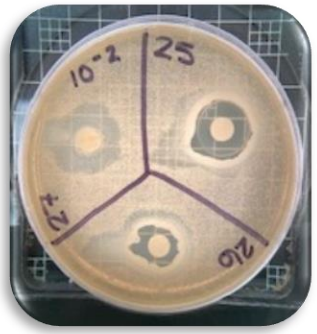
Building the Toolbox for Microorganisms

Screening test
Paper disk method



No visible inhibition

Compatible co-formulant



Visible inhibition

Incompatible co-formulant

Enables quick qualitative viability check

Concentrations: 1 - 5% for the co-formulants
100% for the carriers

		NOP / OMRI	Bacillus Subtilis	Trichoderma Harzianum	Bacillus Thuringiensis	Beauveria Bassiana
Carriers and adjuvants OD (tested at 100% level)						
STEPOSOL ROE-W	Rapeseed Oil Methyl Ester	NOP				
STEPAN 108	C8-10 Triglyceride		Not tested (n.t.)			
Emulsifiers OD						
ECOSTEP AE-13	Polyalkylene Oxide Block Copolymer	OMRI listed				
ECOSTEP BC-12	EO/PO Block Copolymer	OMRI listed				
ECOSTEP CE-13	Castor Oil Ethoxylate	OMRI listed	n.t.	n.t.		
ECOSTEP SE-11	Sorbitan Monoleate Ethoxylate	OMRI listed				
MAKON L64	EO/PO Block Copolymer			n.t.		
NINEX MT-615	Fatty Acid Ethoxylate		n.t.			
STEPAN-MILD L3 G/MB	Lauryl Lactyl Lactate				n.t.	n.t.
STEP-FLOW 2006	Nonionic PEG/PHSA Copolymer		n.t.			
TOXIMUL 8000	Ethoxylated oils	NOP				
Dispersants OD						
STEPFAC 8181 PT3 K	Phosphate Ester, Potassium salt			n.t.	n.t.	n.t.
ECOSTEP PD-5	PEG-PIBSA-TOFA Copolymer	OMRI listed				
Wetting agent OD						
ECOSTEP DOS 60 ROE	Na Dioctyl Sulfosuccinate in Methyl Este	OMRI listed				n.t.
MAKON NF-12E	Alkyl EO/PO Block Copolymer					
MAKON UD-8	C11 Branched Alcohol 8 EO	NOP				

No inhibition at 1 and 5%
No inhibition at 1%, slight or strong inhibition at 5%
Slight inhibition at 1%, slight inhibition at 5%
Slight inhibition at 1%, strong inhibition at 5%
Strong inhibition at 1%
n.t. Not tested

Good biocompatibility of Stepan co-formulants for OD

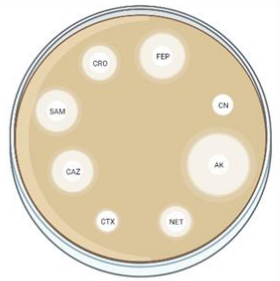
Stepan Trade Names: STEPOSOL®, STEPAN®, ECOSTEP™, MAKON®, NINEX®, STEPAN-MILD®, STEP-FLOW®, STEPFAC™

- Zone of Inhibition (ZOI) testing provides easy visual of compatibility and has enabled formation of an initial toolbox of emulsifiers, wetting agents, dispersants, and carrier fluids/solvents
- Developing microbial technology needs improved support – CAN WE DO BETTER?

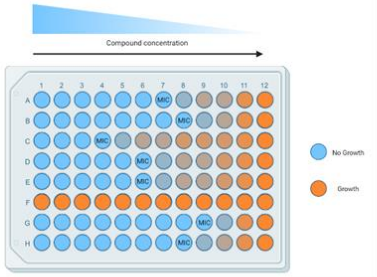
Stepan Co-Formulants Compatibility

- Development focus to date has been on gram positive bacteria and fungi analysis
- The Stepan developed Biological Compatibility Assay is relevant, faster, better and cheaper than traditional methods
- Extending methodology beyond co-formulants testing to enable next generation bioformulations

Traditional Approach

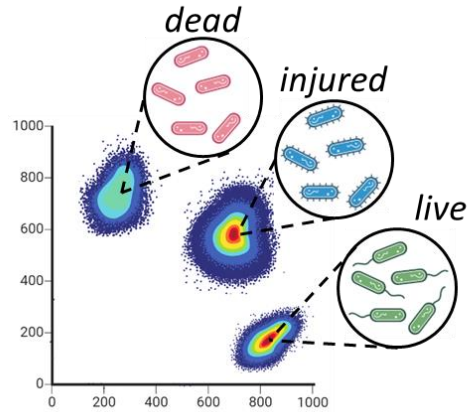


Zone of Inhibition (ZOI)



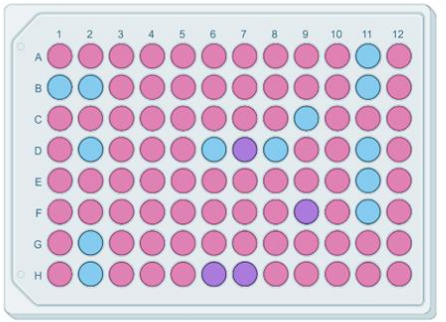
Minimum Inhibitory Concentration (MIC)

Next-Generation Testing



Advanced Biologic Characterization

Test Method	Output Capacity	Time to Data	Sustainable	Ag Application Relevant
Zone of Inhibition Assay (ZOI)	1x	Slow	No	No
Minimum Inhibitory Conc. (MIC)	3x	Slow	No	Yes
Biological Compatibility Assay (BCA)	30x	Fast	Yes	Yes



Superior Biologic Activity Assessment

Proprietary Microorganisms Require Tailored Solutions

You Know Your Active – We Know Formulation Technology

- Stepan Agricultural Solutions' Approach to Formulation Development Focuses on Creating Customized Solutions to Meet Specific Formulation Demands
- Advantages Versus a Chassis Approach:
  - RISK MANAGEMENT: Microbial Production Via Fermentation is Challenging with the Potential for Variation is Batches – Need for Comprehensive Understanding of Edges of Production to Ensure Formulation Robustness
  - PRODUCT DIFFERENTIATION: Preferred Attribute Selection a Key Portion of Product Development – i.e. Rainfastness, Encapsulation Technology, Enhanced Wetting, OMRI-compliant, Method of Application
  - COLLABORATIVE APPROACH: Driving Innovation Takes an Integrated Approach Leveraging the Attributes of the Microbial with Stepan's Expertise in Formulation, Microbiology, Chemistry, and Application Methods.
- Utilizing the Microbial Formulation Toolbox, Stepan is Well Positioned to Accelerate Your Development Timeline and Help Get Your Product to Commercial Status

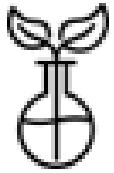
Stepan: Your Partner of Choice

Stepan Agricultural Solutions

Stepan Agricultural Solutions is Committed to Supporting Microbial Product Development

FORMULATION TOOLBOX

- Diverse Range of Surfactants, Dispersants, Solvents/ Carriers
- Customer Coformulant Development Capabilities



BIOLOGICAL FORMULATION

- Understanding of Interaction Between Microbial and Co-formulants
- Proprietary Technology to Extend Shelf-Life and Physical Attributes

ANALYTICAL/ BIOANALYSIS

- Stepan's Biological Compatibility Assay Provides Enhanced Understanding and Insights
- Extension of Technology to Multi-Active Systems In Progress

FERMENTATION PLATFORM

- In-House Fermentation Expertise with Experience Working from Lab to Production Scale
- Multiple BSL2 Laboratories For Development Studies

AGRONOMY/ GREENHOUSE

- Greenhouse Staffed with Research Agronomy Staff
- Ability to Rapidly Test Solutions in Controlled Setting Ahead of Field Trials

GLOBAL NETWORK

- A Globally Connected Team Dedicated to Customer Success
- Collaborative Approach Design to Accelerate Development
- Formulation Training Available In-House or On Site

CULTIVATING *EXCELLENCE*

Stepan Agricultural Solutions

Thank You

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You can also find us on: