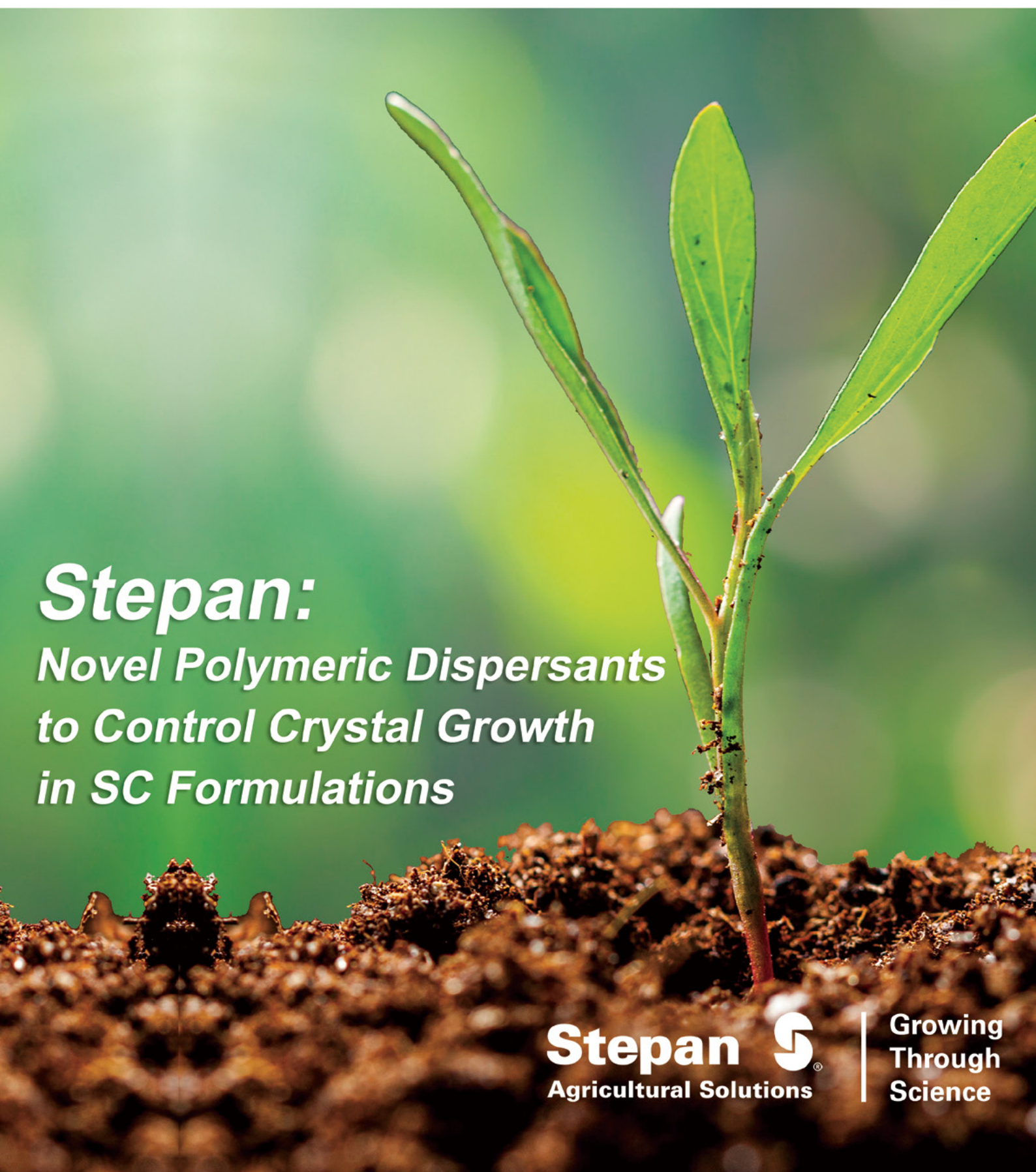


May 2020

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2020 Formulation & Adjuvant Technology



Stepan:
Novel Polymeric Dispersants
to Control Crystal Growth
in SC Formulations

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Stepan: Novel Polymeric Dispersants to Control Crystal Growth in Suspension Concentrate Formulations



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Stepan Company



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Product Development Chemist
at Stepan Company

Over the past decade, the agrochemical industry has seen a rise in suspension concentrate (SC) formulations on the market. In 2014, SC formulations surpassed emulsifiable concentrates (EC) as the most prevalent formulation type defined by market share (Phillips McDougall, 2018). Beyond the removal of costly solvents that may be flammable or irritating, this trend is driven by the pipeline of new active ingredients (AIs) that are generally becoming more complex, with compounds having increased molecular weight, more diverse functionality and chiral centers (Yuan, 2018). These molecules can be more challenging to formulate into solvent-based formulations as their poor solubility limits AI loading. SC formulations provide an excellent alternative to achieve high loading of these complex AIs, while also achieving improved safety and cost savings related to the elimination of solvents.

A key challenge for SC formulations is long-term stability of the dispersion, as AI particles must remain suspended in both the concentrate and dilution stages of the product. Dispersant selection is vital when developing these formulations as it strongly influences stability. One of the most common forms of instability in SC formulations is particle size growth, which can occur through a variety of mechanisms such as Ostwald ripening or agglomeration of the suspended AI particles (Tadros, 2017). The severity of this behavior, referred to as crystal growth, is a function of the dispersant performance. If not prevented, crystal growth will lead to numerous issues like decreased efficacy due to uneven spray application and clogged sprayers.

Dispersion is the process through which agglomerates of solid particles

become separated, and a new interface forms between each of the smaller particles and the surrounding liquid. This process is facilitated by the application of external force (milling) and the use of amphiphilic additives such as dispersants. A key factor that governs the efficiency of this process and the stability of the resulting dispersion is the surface chemistry of the solid that is to be dispersed. The hydrophobic nature of modern AIs introduces a complication into this process, due to their poor interactions with conventional dispersants.

New High Performance Polymeric Dispersants

High performance polymeric (HPP) dispersants are one type of technology that have been developed to overcome this type of challenge. They are larger than surfactants and can have a variety of different molecular architectures (Figure 1). The key feature for this type of dispersant relies on the fact that AIs interact best with affinity groups that have matching chemistry, which enables strong association through available mechanisms such as hydrogen bonding and π - π stacking.

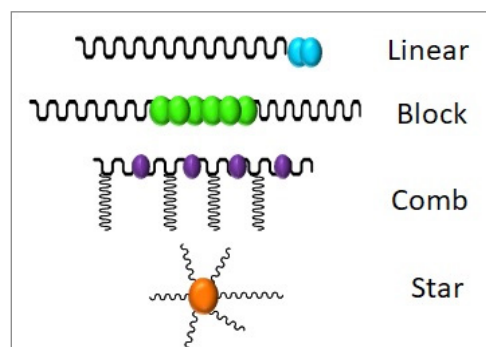


Figure 1. Examples of HPP dispersant architectures.

Stepan has recently developed a new class of nonionic, HPP dispersants. Originally designed for and applied to the preparation of pigment dispersions for coatings applications,

this chemistry platform has found significant utility in the preparation of SCs of hydrophobic AIs. Formulations prepared using this novel, patent-pending technology exhibit superior particle dispersion and demonstrate crystal growth inhibition. A generalized structure of our new HPP dispersants is shown in Figure 2. These dispersants are composed of three discrete components:

1. a linker, which can vary in length, functionality, flexibility, and number of appendages;
2. affinity domains, which are designed to interact with the surface of AI particles, and can vary by the type, number and arrangement of anchoring groups; and
3. stabilizing segments, which can differ by length, hydrophobicity and functionality.

The modular nature of our chemistry platform affords significant flexibility in dispersant design.

Optimizing Structure Design

In order to optimize structure design for SC formulations, more than 60 derivatives of HPP dispersants were evaluated with six different AIs. The STEPSERSE® kit comprising three HPP dispersant molecules emerged as the best candidates for all the AIs screened. These dispersants vary by number of appendages, with the kit containing 1-tail, 2-tail and 3-tail architectures.

This article will focus on the performance of the STEPSERSE kit with Metribuzin and Metalaxyl, two of the most challenging AIs. Both AIs are partially soluble in water (1.1 and 8.4 g/L respectively), which introduces varying severities of crystal growth. SC formulations were made containing 2% dispersant (Table 1). Mill bases were prepared for each AI and were subsequently separated into samples for the dispersant to be shear mixed in. The experimental dispersants are 100% active and were solubilized in glycol prior to addition. It was important for the samples to be prepared immediately and particle size measured after processing to ensure no crystal growth occurred in lead time.

The SC formulations were evaluated for long-term stability at elevated temperature. Metribuzin was held at 54 °C for four weeks and Metalaxyl, which has a lower melting point of 65 °C, was held at 40 °C for eight weeks. In addition, all samples were run through five cycles of freeze-thaw to ensure shelf-life stability. Stability was assessed by suspensibility (ASTM method E1673), particle size measurements and

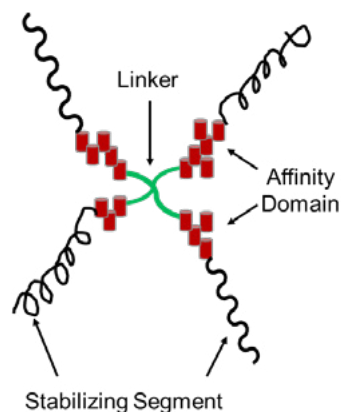


Figure 2. Generic structure of Stepan dispersant.

Component	Role	Metribuzin	Metalaxyl
Pesticide	A.I.	42.0	30.0
STEP-FLOW® 4890SC	Nonionic Surfactant Blend	3.5	3.5
Defoamer	Anti-foam Agent	0.2	0.2
Water	Carrier	42.1	59.1
Xanthan	Rheology Modifier	0.2	0.2
Glycol	Anti-freeze	10.0	5.0
Dispersant	Dispersant	2.0	2.0

Table 1. Formulation breakdown for each active ingredient SC.

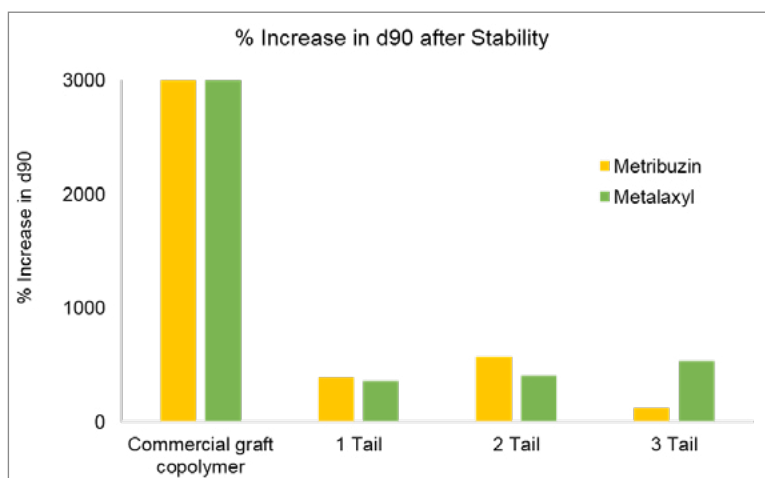


Figure 3. Plot of the percent increase in d90 particle size measurements after stability at elevated temperature for commercial graft copolymer control and three optimized HPP dispersants.

polarized microscopy. In this work, particle size is discussed in terms of d90, which indicates the diameter at which 90% of the total particle volume has a smaller particle size and 10% has a larger size.

Figure 3 summarizes the particle size growth that was observed with these HPP dispersants in comparison to a commercial graft copolymer, a common industry solution for crystal growth inhibition. The commercial control had poor performance with over 3,000% growth in d90 measurements for both Metribuzin and Metalaxyl, whereas the three HPP dispersants exhibited significantly reduced particle growth for both AIs across the stability periods. The 3-tail molecule is the top performing dispersant for Metribuzin, with an increase in d90 from 10 to 25 μm (120%) after four weeks at 54 °C. The 1-tail molecule is the top performing dispersant for Metalaxyl, with an increase in d90 from 7 to 33 μm (350%) after eight weeks at 40 °C.

Polarized microscopy supports that crystal distribution remains much smaller and more controlled with Stepan's new polymeric dispersants. Figure 4 compares 200x magnification images of the commercial graft copolymer control versus the top STEPSPERSE candidate for each active.

The three HPP dispersants discussed in this article clearly show a significant decrease in crystal growth of challenging SC formulations. However, there is still room for improvement to further enhance control of crystal growth with these HPP dispersants in problematic formulations. For example, dispersants milled with the AI will likely have better performance as there will be increased surface contact and better opportunities for particle adhesion. In addition, the formulations assessed have not been optimized. The formulations were developed to stress the performance of the dispersants at a 2% use rate. As a result, stability should be improved with the optimization of dispersant and co-formulant concentrations.

Stepan's new STEPSPERSE kit of HPP dispersants exhibit superior particle dispersion and demonstrable crystal growth inhibition with problematic AIs. In addition, our HPP dispersant platform has developed into a toolbox of more than 150 molecule designs, and Stepan can leverage the modular nature of our chemistry, to identify the best fit for a challenging SC formulation.

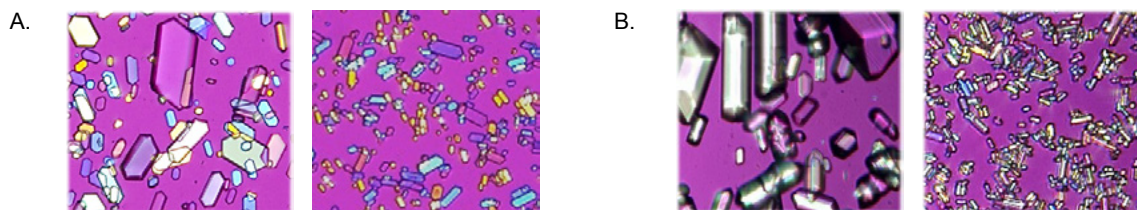


Figure 4. Polarized microscopy of SC formulations after stability at elevated temperature for each AI.

(A) Metribuzin samples: Commercial graft copolymer control (left), 3-tail polymer (right)

(B) Metalaxyl samples: Commercial graft copolymer control (left), 1-tail polymer (right)

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Stepan Company is a major manufacturer of specialty chemicals including surfactants, antimicrobials, fabric softening quaternaries, phthalic anhydride and polyurethane polyols, as well as specialty ingredients for the food and nutraceutical markets. Stepan was founded in 1932 by Alfred C. Stepan Jr. Today, the company has 18 global manufacturing locations, more than 2,100 employees worldwide and over 1,800 product offerings.

Stepan Agricultural Solutions offers a robust pipeline

of innovative products and actively seeks to be the strategic supplier of choice for your agricultural chemical needs. Our global research network and geographic footprint is such that we can effectively meet the needs of our customers around the globe.

In addition, our industry-leading, in-house formulation expertise in emulsifiable concentrates, microemulsions, suspension concentrates and dry products provides a value-added service to help solve customers' most difficult challenges.

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new dispersant platform that offers superior particle dispersion
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GROWING THROUGH SCIENCE

Azelis: Strengthening Innovation Through Formulation, Accelerating Expansion in Asia-Pacific



Kimberly Chung
Asia Pacific Business
Development Director, Azelis

"To strengthen and sharpen our expertise, we invested in three application laboratories dedicated to Agri/Horti in China, New Zealand and Vietnam, to assist customers in developing tailor-made formulations, troubleshooting, and testing their products. We combine ingredients and ideas to create opportunities through our expertise and proactively develop solutions," said Kimberly Chung, Azelis' Asia Pacific Business Development Director in a recent interview with AgroPages.

She also shared her views on Azelis' major businesses, as well as its development strategy in the Asia Pacific region, new brand promise and tagline, the challenges of formulation innovation and possible solutions, and its future strategic plan.

Q1.

Please introduce Azelis and highlight its agriculture business, global presence and core competitiveness.



Azelis is a leading global specialty distributor of chemicals and ingredients. We provide a comprehensive range of products and innovative services to more than

40,000 customers worldwide. Our in-depth local knowledge is supported by an international structure and value-added services including high levels of technical support and tailored solutions.

Azelis Specialty Agri/Horti, established globally, offers a comprehensive range of first class principals for the agriculture, horticulture, amenity, and farm care market segments. Our knowledgeable team has years of experience within the industry. We help customers choose the right product combination and reach their targets in terms of performance, cost-effectiveness, and environmental protection for PPPs (plant protection products), crop nutrition, and seed coating applications.

Following the acquisition of a key global market player in the Agri/Horti industry, and thanks to our strong partnership with Solvay in Europe, we launched the Specialty Agri/Horti market segment in 2017 in the Asia Pacific region where we established a significant presence with local teams in 11 countries.

We have built a strong presence in China and Indonesia. Commitment, focus, technical expertise, customer service excellence and compliance are the main factors of our success. Our teams are working closely together to bring this business

model to each country and share our experiences.

Our lateral value chain allows us to interlink businesses and create new growth opportunities for our customers. We aim to become their partner in innovation, from formulation to production.

To deploy and monitor the growth of our activity regionally, in my role, I work closely with each country to ensure the satisfaction of all our partners, both principals and customers.



Q2.

In recent years, Azelis has been expanding its business in the Asia-Pacific region, what is the strategy behind this expansion? Please talk about such expansions and their value to the industry.

Azelis Asia Pacific has decided to make Specialty Agri/Horti a market segment of focus, along with Food and Health, CASE and

Personal Care, to follow the growing population dynamic in the region.

We believe that our expertise can create value for our customers, who are looking for solutions to overcome technical, environmental and regulatory challenges.

Our sales team has a solid technical background in agriculture. Thanks to their experience and good market connections, they have built stable customer relationships, allowing Azelis to quadruple its turnover in the last three years.

To strengthen and sharpen our expertise, we invested in three application laboratories dedicated to Agri/Horti, in China, New Zealand and Vietnam, to assist customers in developing tailor-made formulations, troubleshooting, and testing of their products. We combine ingredients and ideas to create opportunities through our expertise and proactively develop solutions.



Q3. What is the company's growth plan in China? How do you view the development prospects of the Chinese agchem market?

In the Asia Pacific region, China tends to be ahead in terms of innovative formulations, leading regional trends in the Agri/Horti market segment. Today, our sales team clearly sees a trend towards more sustainable formulations.

To support our customers during this transition, we have been actively working on developing a portfolio that meets their needs. Furthermore, we aim to go further and be their development partner. Thanks to our Shanghai-based laboratory dedicated to Agri/Horti, we are bringing new ideas, new concepts and unique product synergies to create value through formulation support. Our sales, technical and marketing teams are working together, day-in and day-out, to bring outstanding services to customers.

Azelis: Innovation through formulation

In 2019, Azelis launched its new tagline: 'Innovation through formulation', which is a reinforcement of the company's continuous investment in technical expertise. Over the years, the speciality chemicals and food ingredients distributor has been investing resources, both financial and non-financial, in strengthening its innovative services: adding new application laboratories in all regions, creating innovative and award-winning formulations, whilst offering formulation support to its customers. Azelis' owner EQT fully supports the company's direction and offers guidance and advice to further strengthen this role.

Highlights & Rationale

- 'Innovation through formulation' is the company's new tagline and reflects the new strategic direction.
- Azelis has expanded its number of labs from 12 to 60 since 2012 and increased the number of its lab professionals, creating a talented pool with over 1.000 years of cumulative experience in application laboratories.
- The company is proud to have won more than 20 innovation awards in the past three years, all given by independent industry organisations.
- Strong application and formulation support is in line with Azelis' ambition of becoming the benchmark for the industry and market leader in providing innovative solutions to its customers.

Azelis creates value with and for its partners by turning ideas into market-leading solutions that drive growth. The company routinely provides its customers with innovative formulations that address the most stringent market requirements and consumer trends. This is made possible through its 60 application laboratories worldwide, along with its experienced, market-focused sales teams. Azelis has expanded its number of labs from 12 to 60 since 2012 and significantly increased the number of its lab professionals, creating a talent pool with over 1.000 years of cumulative expertise in application laboratories. The high number of application labs allows the company to serve the local market needs while at the same time helping customers to shorten their time to market.

Q4. What are the challenges in formulation innovation and the possible solutions? Could you share some specific cases of how your company helps clients develop innovation formulations suited to different market needs?

The market of Agri/Horti is challenged by the new regulations on fertilizers and pesticides, dependence on the climate, and the expanding food need from consumers, all pushing the industry to innovate.

In the Asia Pacific, the regulation is drastically different from one country to the other. It requires in-depth knowledge to build a portfolio in

line with local needs, but also to support customers during any change. To offer optimum service, we have a regulatory expert within the region who is specialized in the field. We also still ensure that our local teams comprehend the topic well.

Here, we can cite the example of Vietnam, where the government has banned the pesticide glyphosate, used for many years in the industry. This decision was taken by the government to protect consumers, as this herbicide was declared harmful. Farmers have not been able to find an exact replacement despite the fact that there are a couple of products under discussion; they are all yet to be truly verified to emerge as the right match. While the verification is taking place, farmers are facing growing weeds and a decreasing crop yield. We are now working closely with our suppliers and customers to develop a new solution and formulations based on the authorized products.

The final consumers also have an important impact on the Agri/Horti business. On the one hand, the Agri/Horti market is dedicated to feeding the global population. As it directly impacts human health, governments closely monitor and regulate the activity as their goal is to protect the community. On the other hand, the choices and decisions of consumers change the market too. Their requirement for transparency, desire for organic products, pesticide-free solutions and alike are all needs that have reshaped our industry. Therefore, as a solution provider, but also as conscious consumers ourselves, we are developing in Azelis a portfolio of alternative eco-friendly solutions.

Another critical challenge of the Agri/Horti market is the environment. Climate change, but also variations from one year to another, have a significant impact on the business. Although new techniques are developed, as greenhouses, we are still very dependent on this factor, leading to disruptions that we cannot control.

Q5.

What's the strategic plan and the future vision of your company?

Azelis' strategy for the coming years lies on 3 pillars:

- **Expansion in Asia**
- **Digitalization**
- **Sustainability**

We have a strong ambition to become the number one specialty chemical distributor. In the Asia Pacific, we intend to show a similar strength as what we offer to the markets in the Americas and in EMEA. Our team is showing drive, ambition, and motivation to achieve this goal, and is committed to being successful. It should result in a turnover exceeding 25% of the Azelis group sales by 2023.

Azelis has already been investing in digitalization efforts in different regions as part of our strategic direction. The process began in EMEA and the Americas with dedicated platforms providing formulation aid, market insights, product information, or inspiring videos. Both platforms were launched to serve customers in the best possible way. Our digital efforts will only grow in the coming years.



The importance of sustainability and green chemistry has never been higher, and we, at Azelis, hold this call of the industry in the highest regard. Our commitment to both Responsible Care & Responsible Distribution, and our Corporate Social Responsibility (CSR) program help us continually improve our practices. One of the important recognitions of these efforts is the second consecutive Gold rating by EcoVadis, and Azelis has recently joined Together for Sustainability (TfS), a global initiative for sustainable supply chains. We help markets answer the call from the industry and customers. As mentioned earlier, by offering the right ingredients and demonstrating innovative formulations such as clean labels or sustainable product alternatives created by our lab technicians, Azelis works together with the markets for a greener and cleaner future.



A leading fully integrated Specialty Agri/Horti distributor in Asia Pacific

Azelis Specialty Agri/Horti offers a comprehensive range of specialty chemicals and ingredients from first-class principals for the agriculture, horticulture, amenity, and farm care market segments.

Our Specialty Agri/Horti APAC portfolio includes:



Seed treatment

- Pigment (water/oil based)
- Binder latex (water based)
- Stabilizer
- Rheology modifier



Fertilizer

- Biostimulant
- Glycine
- Inhibitors
- Adjuvant
- Microseed
- Water retention
- Antifoam



Drone technology & tank mix adjuvant

- Antifoam
- Silicone synergist
- Super spreader



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SINVOCHEM: Shaping a Professional Agrochemical Adjuvants and Synergist Supplier



Dr. James Qin
CTO & Founder of
SINVOCHEM

Founded in 2008, as a leading Chinese high-tech enterprise engaged in the research, production and marketing of formulate-in and tank-mix adjuvants, SINVOCHEM has, today, grown into a professional agrochemical adjuvants and synergist supplier with businesses in South East Asia, South Asia, the Middle East, Eastern Europe and parts of South America.

What is the mystery behind its rapid growth? With this question in mind, AgroPages conducted an exclusive interview with Dr. James Qin, CTO and founder of SINVOCHEM, who shared SINVOCHEM's thoughts on business deployment, product features, innovation initiatives, strategic collaboration and development planning. These thoughts explained how SINVOCHEM could incorporate innovation, service and sustainability in its development strategy, to make itself an internationally-competitive agrochemical adjuvants and synergist supplier.

"Looking into the future, SINVOCHEM will continue its adherence to its customer application scenario-oriented technical innovation strategy, and will make sustained investments on R&D in cooperation with customers, while focusing on the establishment of an application scenario simulation system. We will make efforts to develop the molecular structure design-focused polycarboxylate and polyether polyol formulate-in adjuvants, as well as tank-mix adjuvants that enhances pesticide delivery in vivo," Dr. Qin stressed.

Q1. Please briefly introduce SINVOCHEM's major business and global presence.

SINVOCHEM is a high-tech enterprise engaged in research, production and marketing of formulate-in and tank-mix adjuvants. Its annual investment on research and innovation accounts for 5-8% of its total turnover. SINVOCHEM has established a research platform which can synthesize new molecular adjuvants and mimic formulation production or spraying scenario. Supported by a constantly-learning and innovative technical team, SINVOCHEM has become China's leading agrochemical adjuvants and synergist player.

Our company has currently served nearly 600 customers worldwide, covering Southeast Asia, South Asia, the Middle East, Eastern Europe and part of South America. In order to better serve customers, we have assisted local agents and terminal customers to establish or upgrade their agrochemical laboratories, or provided them with technical training. We are pleased to see the sustained improvement of product quality and research capacity of our partners, whose products and services are highly praised by local customers in the pesticide industry.

Q2. Could you talk about SINVOCHEM's product series&special strengths, and current application situations? What are the challenges in product development and market extension and possible solutions?

SINVOCHEM adheres to its people oriented policy and environmental-friendly design philosophy when developing pesticide adjuvants.

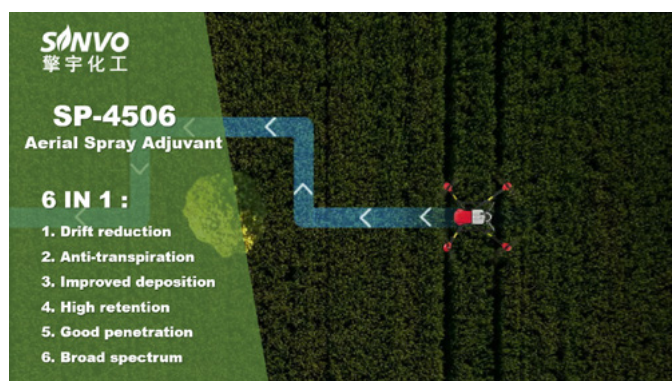
Our product covers formulate-in and tank-mix adjuvants, including polymeric carboxylates, block polyethers, naphthalene sulfonate formaldehyde condensates and wetting dispersants, such as non-ionic polyether, sulfonate and phosphate. Our company's advanced controllable polymerization technology can precisely control product molecular structures. The polycarboxylate dispersant series produced by our company include SP-27001, which improves the processing efficiency of SC formulations; SP-OD3498D, which effectively inhibits crystal growth during the storage of OD formulations to improve stability; SP-3275 which presents high electrolyte tolerance and low temperature tolerance of SC formulations to ensure compatibility with different tank-mix formulations; and SP-DF2222, which realizes high temperature tolerance in the processing of DF formulations. So far, the

polycarboxylate series have been successfully applied to pesticide formulations SC, FS, OD, SE, CS, EW, WG, WP and DF etc..

The life cycle transfer process of pesticide molecules includes dispersion or emulsification, air transfer of pesticide liquid from nozzle to the targeted surface, interface delivery on the target. Our company can mimic foregoing process with application scenarios systems. For example, DF piloting system can accurately simulate real industrial processing; low-speed wind tunnel system can simulate spraying scenario and obtain parameters including droplet size, drift, bound-off, evaporation etc.; data collecting and processing system enable us a better understanding on how to improve pesticide transfer efficacy by tuning formulation components or spray conditions.

We have launched a series of tank mix adjuvants, such as tank-mix compatible phosphate adjuvants SP-42059, which is suitable for the mixed use of pesticides with chemical fertilizers; vegetable oil adjuvant, SP-4506, which effectively reduces the rate of evaporation and increases droplet deposition while keeping modest wetting, spreading and anti-drifting; trisiloxane silicone polyether SP-4026 which presents good compatibility with soybean oil and methyl oleate and significantly improves droplet anti-splashing and spread properties at the dose of 0.03%; SP-4806 which promotes the transfer of pesticide molecules to plant for better delivery efficacy.

Marketing of novel pesticide molecules has become more and more difficult, whilst a mixture of products or higher efficacy



of formulation is appreciated. However, it is a challenging job to develop stable formulation with special technicals such as low melting point, high water solubility or easy decomposition properties. Moreover, target plant characteristics, weather conditions and spraying skills play an important role on pesticide efficacy, so formulation properties should be fine tuned according to application scenarios.

Fortunately, SINVOCHEM has established an application scenario simulation platform which adapts for formulation processing or spraying under mimicking real conditions. Parameters will be collected and processed, thus giving a helpful guideline for modest formulation component. Thanks to application scenarios simulation platform, the massive data thereof drives us to better understand the structure relationship between adjuvants and pesticide molecule. All of these support SINVOCHEM to be one of leading surfactant suppliers who can self-dependently design and industrialize adjuvant structure. It is foreseeable that, based on the optimization of existing adjuvant series, SINVOCHEM will definitely continue its new adjuvants which can smoothly promote formulation processing and effectively improve transfer efficacy of pesticide.

Q3. What kind of product development improvement have you made to cope with the changes in Chinese agrochemical market?

In 2016, Chinese government launched a plan which announced the amount of pesticide or fertilizer should be decreased by the end of 2020, and also listed restrictions on 76 kinds of hazardous solvents or adjuvants. Given the aging of farming labors, drone spraying technology has developed rapidly in China. Accordingly, less diluted formulation or multi- formulation mixture is needed for spray. It requires new formulation properties and new adjuvant to keep dilution stable. SINVOCHEM has actively released several environmental-friendly adjuvants to meet the demands, such as SP-503LE, SP-107LE (non-ionic adjuvant series), which can replace the conventional NP series to be used in pesticide emulsifiable concentrate. A complete evaluation and characterization platform allows for lab simulation of aerial spraying scenario, collection and analysis of performance data of the pesticide molecular transfer process, which in turn guide the adjuvant structural adjustment and product combination, ensuring improved pesticide molecular target deposition rate and biological activity.

SINVOCHEM has established a scenarios-oriented application platform which can simulate spraying or formulation scenarios parameters, thus then collecting and processing data. This platform can help us better understand how to improve pesticide efficacy. For example, multi-functional optical stabilizer Turbiscan can monitor the stability of different formulations after mixing; optical thin-film evaporator can quickly simulate and determine the evaporation rate of pesticide liquid in a specific

environment; high-speed camera can capture the rebound status of droplets hitting the target surface; low-speed wind tunnel system can simulate the wind field environment to test droplet size, drifting and deposition status; and liquid chromatography-mass spectrometry can analyze the biological activity of pesticide on the target. Based on this aerial application scenario platform, SINVOCHEM has launched its aerial pesticide application-product series.

Q4. In your opinion, what are the driving factors to formulation innovation? What measures has your company taken to promote innovation? And what do you think of the role of adjuvant in formulation innovation?

Formulation's innovation is rooted in formulation processing and application scenarios such as spraying, target tissue properties and weather conditions. A good formulation should encompass smooth processing, storage stability, good deposition rate and high biological activity on the target. SINVOCHEM has strengthened adjuvant and formulation innovation platform which includes formulation evaluation system, new molecular adjuvant design and industrialization, scenario-oriented application data collecting and processing unit, high-frequency interaction with customers. Foregoing abilities help SINVOCHEM to better understand customer difficulties and develop new adjuvants. In the circle life of pesticide transfer, adjuvants play a critical role in formulation processing and efficacy delivery. SINVOCHEM still concentrates on the abilities construction in innovation platform.

Q5. So far, who have your partners been? What are the cooperation models?

SINVOCHEM is dedicated to becoming a professional agrochemical adjuvants and synergist supplier. Adjuvant product is a tangible form connecting SINVOCHEM with customers, whilst customized service is the priority of constructing relationship with end users.

For this reason, SINVOCHEM is continuously updating the customer scenario-oriented application platform which can collect and process data covering pesticide life circle from formulation, droplet air transfer, interface interaction on the target to translocation in vivo. SINVOCHEM also conducted technical training courses both online and offline, facilitating a platform for timely and effective customer service. So far, SINVOCHEM has established cooperation with more

than 70% of China's top 100 pesticide enterprises. Meanwhile, in-depth cooperation has been initiated with major dealers and pesticide formulation manufacturers in Southeast Asia, South Asia, the Middle East, Eastern Europe and part of South America.

Q6. What do you think of the changes in the global agrochemical industry? How will SINVOCHEM position and prepare itself to usher in the new challenges and new opportunities brought by the industry consolidation and the changes?

By now, pesticide administration is becoming stricter and stricter while the discovery of novel chemical pesticide molecules has become more and more difficult. On the other side, biopesticide has attracted more attention. In the meantime, pesticide enterprises are collaborating with each other more closely, with the occurrence of intensified mergers and acquisitions. Under the complex circumstance in the agriculture industry, we think that we should be in customer's shoes and provide all-in-one solution to our customers as soon as possible. SINVOCHEM will consistently follow the principle of scenario-oriented application and invest more on R&D to strengthen our ability in developing new adjuvants and technical service.

On the other side, we will also engage in field test with our customers and focus on updating scenario-oriented simulation platform, in the aim of tailor-made service. Furthermore, we will continue to upgrade the safety of production process and consistent product quality, providing satisfied all-in-one solution and meeting the demands of end-users so as to consolidate ourself in the changeful market.

Q7. Could you please describe the development planning and the future vision of your company?

Based on the principle of scenario-oriented application, we will continue to strengthen research on the process of pesticide circle, including dispersion or emulsification, droplet air transfer, interface interaction on the target and translocation in vivo. The built-up of data will promote us to better understand relationship between pesticide, adjuvants, spraying, target properties and weather conditions, further support us on new adjuvants development or new solutions for improved efficacy.

Furthermore, we will continue to adhere to environment-friendly principle and insist on exploring new biodegradable adjuvants and corresponding continuous processing. All in all, we are aiming to provide tailored-in support for the sustainable development of agrochemical industry.

If you are interested in cooperation with SINVOCHEM, please contact:

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BASF: Accelerating Innovation of Formulation Engineering Technology through Digital Technologies



Dr. Lars Wittkowski

Vice President Global Formulation Development & Analytics, BASF Agricultural Solutions

“The intensified use of digital technologies is one of BASF’s guiding principles in strengthening our leading position in chemistry-based innovations. Since the start-up of our supercomputer ‘QURIOSITY’ (1.25 petaflops) mid 2017 numerous contributions from scientific and data driven modeling and simulation of formerly unthinkable complexity had a strong impact on chemical product development including formulation engineering,” said Dr. Lars Wittkowski, Vice President Global Formulation Development & Analytics, BASF Agricultural Solutions in a recent interview with AgroPages.

He also shared his views on challenges and corresponding solutions of formulation engineering technology, some new technologies for formulation engineering, the development of automation control and artificial intelligence in formulation engineering, and some changes in market requirements, regulation & policy and application technologies and countermeasures etc.

Q1. What is the overview of your company’s agrochemical formulation production and major formulation types? Could you highlight the innovation formulation technology and its advantages and application situation?

BASF’s Agricultural Solutions division benefits from a global formulation filling and packaging network, covering North & South America, Europe and Asia Pacific. Global formulation grades are typically produced in bigger manufacturing hubs and distributed to the markets via local repackaging facilities. Local-for-local production concepts are often applied when regional or country specific grades are requested from the market and total cost of supply support this approach.

In recent years, volume breakdown by formulation type did not change significantly. The vast majority is still liquid formulation, e.g. soluble concentrates (SL), emulsifiable concentrates (EC), suspension concentrates (SC), while solid formulations contribute less than 20% to the overall volume.

How does a farmer define a good product? It should be robust, easy to handle, efficient, cost competitive, safe and tailor-made for its specific use. Formulation technology addresses these customer needs and provides innovative solutions. Often, the customers do not see the formulation innovation as such, but they experience the difference in application and performance and ultimately in maximized yield. For example, innovations that reduce off-target movement result in smaller buffer zones, innovations in uptake improve the bioavailability of the active ingredient and innovations in retention and rainfastness reduce the loss rate of the active ingredient. Innovations in formulation technology are of special importance to provide optimized product properties.

Q2. Could you introduce the challenges for formulation engineering technology and corresponding solutions?

When developing formulation technologies, our challenges reflect those of our customers – from changing climatic conditions and regulatory requirements to the targeted and efficient application of plant protection products.

We give farmers clear advice on how to use and take advantage of our top innovations like our Revysol® fungicide products under different and difficult climate conditions. Resilience against climatic stress is a major priority in our research and development. In our laboratories we focus on protecting our products against UV stress, strong rainfall events and adverse drift scenarios. Reducing the photo-degradation of active ingredients will increase the activity level, and consequently lead to a more consistent performance. We have established an approach to select UV blockers via lab simulations and are optimizing formulations in terms of their performance and cost efficiency. Carefully tailored adjuvants and other performance enhancing ingredients increase retention and uptake of active ingredients into the deep layers of the leaf structure and safeguard quick action. At the same time, they help to withstand heavy rain events without loss of activity.

Another frequently encountered challenge involves

stabilizing multiple active ingredients (AIs), sometimes up to 4 or 5, in a single product. Often, there are physicochemical incompatibilities between the AIs that need to be overcome, especially when it comes to biological active ingredients, such as endospores, proteins or peptides. The associated challenge is to co-stabilize multiple AIs that belong to completely different classes of active ingredients and develop shelf stable products that are efficacious. BASF's Poncho® Votivo® 2.0 is one such example. This seed treatment formulation contains a chemical insecticide, two biological endospores as well as an enzyme, and offers an excellent shelf life. The product provides best-in-class protection against insects and nematodes with an added advantage of improved soil health that adds to yield benefits.

To further optimize on target application of plant protection products, BASF has opened a global Agrochemical Application Research Center (AARC) in Research Triangle Park, North Carolina, USA, in 2019. The AARC provides a state-of-the-art wind tunnel to test the drift potential from spray applications by measuring the droplet size distribution in each crop protection product. Formulations can be analyzed via spraying them into a controlled air stream using the same nozzles available to growers. Droplet size distribution is important because it is used to determine the size of land buffers that are required for acceptable product application in commercial settings. Research conducted at the facility helps to optimize stewardship guidelines regarding on-target application and to address application buffer zones for BASF crop protection products used worldwide.

Q3. Could you share some new technologies for formulation engineering like Modelling & Simulation, 3D rendering & Virtual reality etc., and their application situations?

The intensified use of digital technologies is one of BASF's guiding principles in strengthening our leading position in chemistry-based innovations. Since the start-up of our supercomputer 'QURIOSITY' (1.25 petaflops) mid 2017 numerous contributions from scientific and data driven modeling and simulation of formerly unthinkable complexity had a strong impact on chemical product development including formulation engineering, for example:

- Quantum chemical modeling of surfactant and polymer mediated interfacial stabilization provide valuable input for the design of formulation compositions to achieve optimized performance in the application.
- Modeling solvency of active ingredients and dispersibility of hydrophobic particles and liquids in water helps to predict new polymer structures with improved formulation performance and was successfully used already in the development of complex formulations.

Q4. Could you talk about the development of automation control and artificial intelligence in formulation engineering?

High throughput technologies including flow chemistry set ups have been successfully used for many years with design-of-experiment (DOE) based screenings for formulation recipe development and application optimization. Modern technologies based on statistical and physical multidimensional methods combined with self-optimizing algorithms ('artificial intelligence') will be applied more and more in chemical product development. They allow accelerated development times and/or achieving performance levels in complex systems in short time. For example, we are using an interactive decision support framework that assists lab researchers in finding optimal product recipes within a few experimental iterations.

Q5. Could you share some changes in your target markets in market requirements, regulation & policy and application technologies? What improvements/adjustments have been made in the formulation development and production to address these changes?

New regulatory requirements are constantly evolving in all our markets, e.g. regarding the biodegradability of products, microplastics or changes in adjuvant policy in Europe. Other regions focus on other aspects or pursue different timelines.

Evolution in regulations and policies is good and vital for progress in sustainable farming. This does not only drive innovation, but also allows us to show our strength in this area. However, in our industry we need a predictable, science-based evolution aligned with our time- and resource consuming product development cycles. It takes more than 10 years to develop a plant protection product and up to 300 studies are performed to ensure highest regulatory standards.

The development of novel application technologies is progressing fast and will change how plant protection products will be applied in the future. Application may shift in some areas from broadcast to spot, with further advancement down to an individual plant level. The underlying technologies will have an impact on the formulation properties, e.g. their viscosity, concentration or mixing compatibility as well as on the kind of chemistry that can be applied.

Now, it is key to understand and apply these new requirements to our future products, to be able to offer innovative products to the market. It will take some more years before these technologies take substantial market share, but change will happen, and we prepare for it now.

FMC: Strengthening the Application of Automation Control and Artificial Intelligence in Formulation Development and Engineering



Sergiy Paleshanko

Global R&D Manager,
Formulation at FMC



Albert Siuta

Director Global Formulations and
Process Development at FMC

“At FMC, automation control and artificial intelligence are areas of growth in formulation development and engineering. In scale-up and manufacturing, the use of fully automated production and packaging lines with advanced sensors and AI to control and optimize processes is growing,” said Sergiy Paleshanko, Global R&D Manager, Formulation at FMC and Albert Siuta, Director Global Formulations and Process Development at FMC in a recent interview with AgroPages.

They also shared their views on challenges and corresponding solutions of formulation engineering technology, some new technologies for formulation engineering, the development of automation control and artificial intelligence in formulation engineering, and some changes in market requirements, regulation & policy and application technologies and countermeasures etc.

Q1. What is the overview of your company’s agrochemical formulation production and major formulation types? Could you highlight the innovation formulation technology and its advantages and application situation?

FMC Corporation has production capabilities present in all major geographies and manufactures several types of formulations. Our work on the development of new innovative solutions in formulation technology is driven by customer needs together with current and future regulatory requirements. FMC is continuing to expand its product pipeline with innovative formulations, including water-dispersible granules (WG), Oil dispersions (OD) and Fertilizer ready formulations (LFR technology).

WG formulations are valued for being non-dusty which reduces inhalation hazards, high-loading of active ingredient is possible and there is no crystal growth or sedimentation. WG formulations are good for use in drone applications because they overcome solubility and some AI stability issues associated with some liquids. Additionally, they use less water and can use higher strength formulations. Some specific FMC WG products include

ALTACOR[®] insect control, Avaunt[®] 30WG insecticide, Authority[®] Maxx herbicide and Rustler[®] selective herbicide.

OD formulations are in demand for their ability to formulate hydrolytically unstable active ingredients as liquid formulations, and their built-in adjuvant ability that improves efficacy by enhancing spray retention and active ingredient penetration. Some specific FMC OD products include Benevia[®] insecticide, Travallas[®] herbicide, Omnera[®] LQM[®] herbicide and Sentrallas[®] herbicide.

LFR technology formulations benefit from FMC’s patented Liquid Fertilizer Ready[®] formulation technology that allows it to combine easily in the tank with liquid fertilizers. LFR technologies are optimal for in-furrow soil applications to reduce insect injury, lower potential disease entry sites and improve overall plant health for maximum yield potential. A key FMC LFR product includes Capture[®] LFR[®] insecticide. FMC offers a patented 3RIVE 3D[®] application technology for in-furrow use that integrates formulation technology, application technology and active ingredients to help growers farm faster while using less water, fuel and labor.

FMC also offers PrecisionPac[®] application innovation to allow

retail agronomists to create custom herbicide blends unique to individual growers and their crops or fields.

Q2. Could you introduce the challenges for formulation engineering technology and corresponding solutions?

With the introduction of novel technologies and the development of multiple formulation types, formulation engineers are challenged with different scalability and manufacturing processes while delivering products with consistent and satisfactory performance specifications. Additionally, market demand for products may unexpectedly change and manufacturing processes and systems must be able to efficiently respond. These challenges must be addressed with innovative approaches that allow for minimum waste and rework materials. Various engineering solutions have been developed to address a range of conditions which may change during manufacturing of agrochemical products, including blending (liquid or dry), milling (wet and dry), granulation, extrusion, encapsulation and many other processes. It is also important to address potential challenges raised from the changes in active ingredient manufacturing processes and variations in the quality of co-formulants.

At FMC, some of these engineering solutions include unique in-house developed encapsulation and milling technologies, process intensification to increase capacity and reduce costs, in-line formulation parameter measurements and the design and utilization of multi-purpose facilities that are highly productive with a fast turnaround.

Q3. Could you share some new technologies for formulation engineering like Modelling & Simulation, 3D rendering & Virtual reality etc, and their application situations?

At FMC, we leverage several modelling and virtual technologies that play a substantial role in the development of agriculture chemical products. We apply these novel approaches in every aspect of product discovery and development. In engineering, we use tools that enhance the robustness and efficiency of engineering solutions during the development of the scale up and commercial manufacturing processes. 3D rendering is used to aid engineers in manufacturing plant design. Advanced modelling and simulation tools are used in process optimizations such as mixing, granulation and cycle time analysis. These tools provide valuable information which help formulation engineers to examine the flexibility in chemical process design and identify potential solutions for the troubleshooting of manufacturing processes.

Q4. Could you talk about the development of automation control and artificial intelligence in formulation engineering?

At FMC, automation control and artificial intelligence are areas of growth in formulation development and engineering. In scale-up and manufacturing, the use of fully automated production and packaging lines with advanced sensors and AI to control and optimize processes is growing. For example, the precision dosing of ingredients at registered levels is required for a GMP-level certificate of manufacturing.

FMC has several examples of automation control and AI in place. In our application technology teams, a focus on automation control has led to breakthroughs such as our 3RIVE 3D® “foam” application, PrecisionPac®, and numerous other advances underway in the precision agriculture arena.

Q5. Could you share some changes in your target markets in market requirements, regulation & policy and application technologies? What improvements/adjustments have been made in the formulation development and production to address these changes?

Regulatory challenges vary from country to country and can require significant customization and time investment for reviews and registrations. Some examples include regulatory-driven replacement of inert ingredients and limiting use of active ingredients. A recent example is the European Chemical Agency’s proposal to limit the use of certain microplastics which will impact seed treatment and microencapsulated formulations. FMC is actively researching new and more sustainable alternatives to the use of microplastics in formulations while concurrently exploring novel engineering solutions to accelerate commercialization.

Another important trend is sustainability which includes conservation of energy, water and the reduction of emissions as well as the overall environmental footprint. To help address this trend, FMC introduced 3RIVE 3D® application technology to more efficiently apply products and reduce the usage of time, labor and water. In North America, Capture® 3RIVE 3D® insecticide and Ethos® 3D insecticide/fungicide were formulated to deliver crop protection for seeding defense and yield enhancement. These two product offerings were specifically designed for use in the 3RIVE 3D® application system which was recognized with a 2018 Agrow Award.

The use of biologicals as pesticides or biostimulants is another area that FMC continues to invest in to bring new products to the marketplace. FMC is looking at ways that biological technologies and associated formulations can differentiate products as well as improve the sustainability of the portfolio. The formulation of these biologicals requires the additional challenges of maintaining the health of the biological during processing and storage. FMC recently added new fermentation capability to enable us to produce more quantities of biologicals at our European Innovation Center at Denmark and we are exploring ways to leverage these learnings at other sites.



Overview of Aerial Application of Pesticide Formulation & Adjuvant Technologies Launched in China



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In 2019, China's aerial pesticide application sector ushered in a boom period. As of December 2019, the number of China's aerial application UAV reached 50,000 units, becoming the country with the largest number of aerial pesticide applicators that can cover a service area of over 30 million hectares. Aerial pesticide application UAV has developed rapidly in China, but the available pesticide formulations fit for aerial application is inadequate. More research into pesticide formulations, such as anti-drifting and anti-evaporation formulations, should be conducted, accompanied by selected adjuvants for aerial pesticide applications, especially versatile adjuvants with the functions of anti-drifting, anti-evaporation, enhancement of deposition, adhesion and absorption.

Droplet size, flight height and meteorological conditions are all key factors in the drifting of pesticides. For this reason, many practices and explorations have been carried out within the industry to improve anti-drifting techniques, such as improving nozzle design, increasing droplet size, changing droplet electric charge, enhancing absorption, adding adjuvants and changing the physical property of droplets. Above all, the development of anti-drifting pesticides and adjuvants has become a key goal of leading pesticide companies worldwide, which are constantly improving their techniques and accelerating their releases of upgraded products. Now, let us follow these companies to see what they have explored in this regard, and what products they have launched that are worthy of note.

FMC: Kuanxinfei

Since September 2018, FMC officially released its UAV application operations, represented by the product, Coragen® (20% chlorantraniliprole SC). Thereafter, FMC has been exploring and trying to achieve breakthroughs in UAV application technology. As a result, on 30th April, 2019, FMC published an aerial application technical guideline for its metamifop herbicides, Daoqingqing (5% metamifop+ 5% cyhalofop-butyl EC) for use on rice, which again began a new era of aerial pesticide application.

Coragen® (200g / L chlorantraniliprole SC) is efficient and flexible in tank-mix operations, making it suited to aerial pesticide applications.

The patented compound, metamifop, Hanqiuha® (10% metamifop EC) also launched by FMC, can control various types of grassy weeds, such as paddy barnyard grass, moleplant seed, crab grass and eleusine indica. The product is safe and has low toxicity, good solubility, low volatility, high flash point, high specific weight and low viscosity, reflecting its compliance to aerial pesticide application requirements.

FMC's fungicide, Liangyou® (16% trifloxystrobin + 32% tebuconazole), is a novel field fungicide launched by the company in 2020, with a content as high as 48%. It is an ideal fungicide for controlling rice sheath blight, false smut and wheat powdery mildew. As the highest AI content-containing in SC formulation fungicide, it features the advantages of easy to use, fast dissolution, and smooth spraying, making it good for aerial pesticide applications and enhancement of plant potential. The product provides an efficient and multiplied pest control experience.

Syngenta: Yilaituo®

With the rapid development of aerial pesticide application, Syngenta launched its U-Companion brand dedicated to aerial application, which released many products. Meanwhile, the company will work with industry partners to conduct a series of UAV safety and aerial application-related training courses, which will integrate "safe application + technical criterion + product service" practices to achieve Syngenta's corporate vision of sustainable development and precision agriculture.

In March 2019, Syngenta released its aerial pesticide application-oriented Yilaituo® (difenoconazole+propiconazole), which is highly effective in controlling rice sheath blight, rice false smut and rice kernel smut. Yilaituo EC is highly compatible to spraying systems, being suitable for use with mainstream pressure spray heads and centrifugal spray heads. Accordingly, smooth spraying is ensured.

In terms of tank-mix tests and trials, Syngenta has conducted a stability test on high concentration diluents, which showed good stability through the mixed use of Yilaituo with the common formulations of Syngenta that is suitable for aerial pesticide applications. The results of field trials show that the effect of Yilaituo is stable. During testing, Yilaituo's adhesion to leaf surfaces was satisfactory, and it diffuses well and acts effectively on crops.

Yilaituo has been widely used in the rice production areas of Heilongjiang, Jiangsu and Anhui provinces in China. At the end of 2019, its use via aerial spraying covered more than 66,600 hectares of crop land.

"BASF takes you to fly"

In 2018, BASF's Agricultural Solutions launched a special aerial pesticide application program in China, titled, "BASF takes you to fly." The program integrates BASF's innovative fungicides, Opera® (12.3% pyraclostrobin + 4.7% epoxiconazole) and DAO QING® (9% pyraclostrobin), which are dedicated to aerial application and provide growers in China's main rice and wheat production regions with UAV spraying options, helping them save labor costs and maximizing agricultural productivity to achieve yield increases. In 2018, the program completed aerial applications on over 6,600

hectares of crop land in China. Through continued product introduction and promotion, BASF's program has covered major crops in China, especially high-value cash crops and vegetables.

So far, BASF's products suitable for aerial application include BASAGRAN®, DAO QING®, ALLEGRO®, ADEXAR®, OPUS®, YINGWEI® and ARIETTA®.

Corteva Agriscience: ZORVEC ENIBEL®

Corteva's ZORVEC ENIBEL® is the first premix product in its Zorvec® series.

ZORVEC ENIBEL (oxathiapiprolin 2.8% + famoxadone SC 28.2%) has a unique action site and brand-new action mechanism, which achieve a satisfactory fungicidal effect via the inhibition of OSBP. This efficient oomycete technique decreases management costs and increases agricultural operation efficiency. It is also an ideal agent for comprehensive disease control, and its added famoxadone broadens its fungicidal spectrum to effectively control late blight and early blight. It is an effective formulation that can be easily used for aerial applications.

ADAMA: Lingshan®

In line with the new trend for pest control, ADAMA has launched an aerial application-oriented insecticide, Lingshan®, which is a buprofezin 40% SC. Buprofezin is one of the most successful insect growth regulators in the world, which can effectively control homoptera pests. After the formulation optimization conducted by ADAMA Nanjing R&D Center, buprofezin's long-lasting effect and high selectivity properties have been fully utilized, which is especially suitable to new application methods such as aerial spraying. Meanwhile, its mixability with other conventional pesticides has also been improved.

Guangxi Tianyuan: Ultra Low Volume Liquid

Back in 2009, Guangxi Tianyuan Biochemistry began the research and development of the ultra-low volume (ULV) application technology, the high efficiency application technique and the aerial application-oriented techniques. By 2013, the company filed 128 ultra-low volume patents, having been delegated by the Chinese Ministry of Agriculture and Rural Affairs to establish a Key Lab for Research and Development of Pesticide Formulation and Application Technique.

At present, Guangxi Tianyuan is the first ULV registered company in China and the only enterprise registered for application to field crops. The company has so far achieved application registrations of more than 30 products and owns 17 certified ULV products. Moreover, 109 patents related to

ULV products and spraying operations have been filed. Guangxi Tianyuan's ULV series has the advantages of anti-drifting, anti-evaporation, high stability and good mixability (Table 1).

Nanjing Scienx Ecotechnology: Nanopesticide

Since 2016, Nanjing Scienx Ecotechnology has been focusing on the research of aerial pesticide application-oriented formulations for the control of rice and wheat insect pests, having successfully used the nanotechnology to develop a water-based nano-formulation dedicated to aerial application for use in rice and wheat fields. The relevant products have the advantages of application reduction and efficiency improvement, green and safe, easy to handle, which can be customized according to the requirements of clients.

Over the last three years, besides the nano-pesticide verification test carried out nationwide, the company has conducted a number of exploratory field efficacy trials and applications of maturational nano-pesticide products. According to statistics, in 2017, the exploratory field efficacy trials and applications were conducted in 24 locations, which increased to 34 in 2018 and further increased to 62 in 2019. The trial and application area has reached accumulatively to 666,000 hectares.

Until now, the pesticides, which can be manufactured via nanotechnology, are shown in Table 2.

In response to the aerial pesticide application-oriented formulations required for the control of corn *spodoptera frugiperda* and cabbage diamondback moth, the company developed the emamectin benzoate micro emulsion 5.7% and 3.4%, respectively, which are not added to any organic solvents or cosolvents, and the adjuvants being used are natural products or natural derivatives which are environment-friendly and biodegradable. Before and after dilution, the pesticide particles have a good stability and dispersity and the formulations have a high viscosity. The relevant product field trials and efficacy tests have been conducted nationwide, with results showing a fast-acting and long-lasting effect. Moreover, the nanopesticides - emamectin benzoate mixing with lambda-cyhalothrin, emamectin benzoate mixing with indoxacarb, have a control efficiency of above 90% in 3d and 7-10d after application. According to statistics, in 2019, the emamectin benzoate micro emulsion 5.7% was used for a demonstrative control of *spodoptera frugiperda* in the provinces of Yunnan, Guangdong, Guangxi, Jiangsu, Anhui, Hainan, Heilongjiang, Hebei, Shandong and Fujian for an area of nearly 15,000 hectares, having proved its quick and long-lasting effect.

Serial No.	Certification Number	Pesticide Name	Formulation Type	Content	Registration Owner
1	PD20151781	Emamectin benzoate	ULV Liquid	1%	Guangxi Tianyuan Biochemistry
2	PD20184190	Ethephon	ULV Liquid	4%	Guangxi Tianyuan Biochemistry
3	PD20183948	Chlorantraniliprole	ULV Liquid	5%	Guangxi Tianyuan Biochemistry
4	PD20182484	Dinotefuran	ULV Liquid	3%	Guangxi Tianyuan Biochemistry
5	PD20182176	Diazinon	ULV Liquid	20%	Guangxi Tianyuan Biochemistry
6	PD20171557	Indoxacarb	ULV Liquid	3%	Guangxi Tianyuan Biochemistry
7	PD20171507	Abamectin	ULV Liquid	1.5%	Guangxi Tianyuan Biochemistry
8	PD20171283	Nitenpyram	ULV Liquid	5%	Guangxi Tianyuan Biochemistry
9	PD20161195	Difenoconazole	ULV Liquid	5%	Guangxi Tianyuan Biochemistry
10	PD20160999	Tebuconazole	ULV Liquid	3%	Guangxi Tianyuan Biochemistry
11	PD20152045	Azoxystrobin	ULV Liquid	5%	Guangxi Tianyuan Biochemical
12	PD20182485	Thifluzamide+Epoxiconazole	ULV Liquid	6%	Guangxi Kangsaide Agrochemical
13	PD20183950	Thifluzamide+Epoxiconazole	ULV Liquid	6%	Nanning Defeng Chemical
14	PD20182482	Emamectin benzoate+Indoxacarb	ULV Liquid	6%	Nanning Defengfu Chemical
15	PD20184101	Abamectin+thiamethoxam	ULV Liquid	4%	Henan Jintiandi Agrochemical
16	PD20181057	Thiamethoxam	ULV Liquid	3%	Henan Jintiandi Agrochemical
17	PD20181029	Pyraclostrobin+Tebuconazole	ULV Liquid	10%	Henan Jintiandi Agrochemical

Table 1. Registration overview of ULV formulation in China; Source: ICAMA

Crops	Target of Control	Optional Pesticide Varieties	Notes
Rice	Rice plant hopper	Thiamethoxam, acetamiprid, nitenpyram, dinotefuran, sulfoxaflor	With regard to the amount of active ingredients of each product variety, please refer to the defined amount of use in respective registrations.
	Rice leaf roller	Emamectin benzoate, abamectin, Indoxacarb, methoxyfenozide, dinotefuran	
	Borer (rice stem borer, pink rice borer)		
	Rice blast	Kasugamycin, trifloxystrobin+tebuconazole, difenoconazole+propiconazole, prochlorazole+Tebuconazole	
	Sheath blight	Validamycin, trifloxystrobin+tebuconazole, difenoconazole+propiconazole, thifluzamide+tebuconazole	
	Rice false smut	Trifloxystrobin+tebuconazole, epoxiconazole, thifluzamide+tebuconazole, Validamycin, hexaconazole	
	Bacterial streak	Octymycin acetate+oligosaccharins	
Wheat	Gibberellic disease (powdery mildew, sheath blight)	Prothioconazole+tebuconazole, trifloxystrobin+tebuconazole, prochloraz+tebuconazole, pyraclostrobin+tebuconazole	
	Armyworm, midge	Lambda-cyhalothrin	
	Aphid	Imidacloprid, thiamethoxam, dinotefuran, lambda-cyhalothrin	

Table 2. The pesticides manufactured via nanotechnology

Veyong Biochemical

Since 2011, Veyong Biochemical has established an aerial application program, having formed its professional research team engaged in the selection of products from the years of solutions, as appropriate to the needs of aerial application. Through the study and assortment of data related to rice, corn and wheat-targeted formulations and the effect of control, Veyong R & D Center has formulated its production standard as applicable to aerial application, such that the company can be shaped into a professional supplier of aerial application-oriented pesticide formulations.

In the 4th Safe and Scientific Pesticide Application Demonstration Appraisal Meeting, the company's Veyong Rice Yield Increase and Health Management Solution was honored as the "2018 Excellent Crop Health Management Solution". The aerial application-oriented formulations launched by the company include azoxystrobin SC, clothianidin SC and thidiazuron+diuron.

By the end of 2019, Veyong Biochemical had carried out more than 100 agricultural aerial application demonstrations in 18 provinces, including Hebei, Henan, Hunan and Xinjiang. Its satisfactory control effect is regarded highly by users, while the accumulated applications have covered 666,000 hectares of agricultural land.

Solvay: Tank-mix adjuvant

For more than 20 years, Solvay has been a leading formula designer of agricultural tank-mix adjuvant. The natural guar gum modified polymer is the core technology platform of Solvay's adjuvant development program, which has accumulated decades of research and production experiences worldwide. Up to now, six series tank-mix adjuvant products have been developed, which are of guar gum anti-drifting capability and have synergistic functions. The guar gum anti-drifting products of the company have played an important role in solving the complex process of pesticide spraying.

In the field of guar gum technology, the latest generation oil-based multi-purpose AgRho® Starguar adjuvant released by Solvay integrates various effects such as anti-drifting, anti-evaporation, anti-bouncing, rain fastness and synergism.

The AgRho Starguar Control was launched in 2015, which is the first adjuvant for use with dicamba, being approved by the US Environmental Protection Agency as a mandatory DRA to reduce and control the risk of droplet drift during the spraying of dicamba in a soybean crop field. This product has been applied to 10 million hectares of crop land in North America and will be widely used in Brazil from 2021. The other oil-based emulsion anti-drifting product, AgRho Versa Twin, is a result of a breakthrough in droplet size, retention, bouncing and surface adhesion. It was first launched in 2007 being applied to the Roundup Ready GM soybean, having been used in the US covering more than 30 million hectares of crop land. It is one of the popular brands among American farmers.

Aiming at China's aerial pesticide applications, Solvay has launched its AgRho® Aeromate series, based on the remarkable field trial results. In 2018, Solvay successfully launched AgRho® Aeromate 320 and AgRho® Starguar 4A in the Chinese market. Through its anti-drifting, anti-evaporation and anti-bounce features, the product can accurately locate and directly act on the target, with the achievement of enhanced efficacy. Solvay has been making continuous innovation and in 2019 launched the latest high-concentration guar gum anti-

drifting product AgRho® Aeromate 380, which provides a variety of optimized performance and options for aerial pesticide applications aiming at improving the biological efficiency.

Agricultural tank-mix adjuvant is expected to continue its rapid development and will become an advanced tool for the development of precision agriculture in the future. In the US, Brazil, Australia and Europe, especially while spraying of a variety of herbicide mixtures, the tank-mix adjuvants will help improve the safety, reduce the amount of application and minimize the losses from the target of the application. The adjuvant development will also promote the development of the UAV and other new spraying technologies in the course of the agricultural digital revolution in China.

SINVOCHEM: SP-4506 synergist

SINVOCHEM is a national high-tech enterprise dedicated to the development of polymer surfactants for environment-friendly applications. The SP-4506 developed by the company is a synergistic agent which can regulate the droplet diffusion after spraying, which are evenly sprayed and diffused, with a good anti-drifting effect. At the same time, the product has a good anti-evaporation property in high temperatures and dry environment, to ensure the effectiveness of the application. The product is fit to use in a tank-mix aerial application and can also be used in other applications such as a mechanical boom sprayer and air-assisted sprayer. It is mainly used to solve the problem of droplet vaporization and drifting with the wind in the course of droplet transmission under the high-concentration dilution circumstance, whilst enhancing the adhesive force and wettability of droplet.

When being used in a tank-mix aerial application, it can improve the dilution stability of the liquid to effectively maintain the droplet size within a reasonable range of diffusion, such that the drift is reduced, droplet deposition is facilitated, evaporation is controlled and adhesion to crops is improved.

Momentive: Silwet adjuvants

Momentive Performance Materials is a global organosilicon industry leader, being the forerunner of agricultural organosilicon industry. The company has done considerable research into pesticide formulation, tank-mix and aerial pesticide applications. The company provides customers with high-quality products and technical guidance, supported by its detailed and precise data. The Silwet synergistic agents released by the company has stood out prominently for its effective control of the resistant insect pests and weeds as well as for its adaptability to aerial application.

The Silwet aerial application-oriented adjuvants have the characteristics of anti-flocculation, anti-drifting, anti-evaporation, deposition and efficiency enhancement, which can effectively solve the problems encountered in the process of aerial pesticide application.

Guilin Jiqi Biochemical: "1-spray 3-saving" adjuvants

The "1-spray 3-saving" adjuvant launched by Guilin Jiqi Biochemical contains hyper-branched fatty amine-modified polymer, hyper-branched fatty alcohol ether modified polymer and polyoxyethylene ether-based modified trisiloxane compound, which are the main ingredients. The product not only has the advantages of anti-drifting and anti-evaporation but also has a good spread, penetration and systemicity, which can effectively improve the utilization rate of pesticides. This kind of adjuvant is of minimal toxicity, almost non-toxic after dilution, being safe for crops and the environment.

The Nongjianfei adjuvant released by the company has the following advantages:

- Reduction in the surface tension of the pesticide diluent and enhancement of the atomization effect;
- Increase in droplet deposition;
- Improvement in the anti-drifting property of droplets, reduction in the interference caused by the turbulence of UAV, mitigation of pesticide damage and improvement in the utilization rate;
- Improvement of the adhesion, wettability and spread of the liquid to improve the efficacy and reduce the interference of airflow on the deposition of droplets;
- The reduction of the evaporation of droplets under high temperatures and prolonging of the duration of action.
- Rainfastness, reduction of the losses of active ingredients of pesticides.

Beijing Grand AgroChem: Maifei

The aerial application-oriented synergist Maifei developed by the Beijing Grand AgroChem has the advantages of anti-drifting, anti-evaporation, enhanced deposition, adhesion and absorption. The test results show that the adding of the spray adjuvant Maifei in the process of aerial application will reduce the amount of use, which helps to achieve the high utilization rate of 40%, which is beneficial to the realization of the negative growth of pesticide use.

The product can be mixed with the aerial application-oriented pesticide formulations available on the market, thus significantly improve the utilization rate of pesticide formulations sprayed via aerial applications. So far, the product has been widely promoted and used in Northeast China, Northwest China, East China and Central China, having been highly regarded by crop protection companies, aerial application services and major growers.



iFormulate: Emulsifiable Concentrates (EC) – The Future of Agrochemical Formulation?

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There can be little doubt that in all markets, not just agrochemicals, there is a drive to more sustainable and environmentally-friendly products.

Delivering products with these claims has been hampered by a number of different factors. Whilst the definitions of sustainability in particular has been helped by the publication of the United Nations Sustainable Development Goals, there remains a significant hurdle in all markets, namely do the new products still work, both functionally and economically?

In agrochemicals the Emulsifiable Concentrate (EC) formulation is a traditional formulation type and is in essence a very simple formulation consisting mainly of the active ingredient, a solvent and an emulsifier system which helps to provide the instant emulsification when the product is added to the spray tank. The manufacture of EC formulations is also very simple with little specialised equipment required and conventionally involves simply dissolving the active ingredient in the appropriate solvent and then adding the emulsifier under agitation. Final tests include simple appearance, assays to verify concentration, specific gravity, viscosity and emulsification checks. CIPAC methods are available for all of these¹.

This formulation type seemed an obvious target for replacement due to the use of unfavoured aprotic solvents such as N-methyl pyrrolidone (NMP), dimethyl sulfoxide (DMSO) and flammable aromatic solvents such as xylene and the heavy aromatics often referred to by the ExxonMobil brand name of Solvesso. The demise of this formulation was predicted by many but has this actually happened?

If we look at the EC format and its frequency of use in the Pesticides Manual, then in 2013, there were 339 actives listed as being formulated as an EC, in 2016, we reported² that there were 459 active ingredients that were stated as being available in the EC format and that was the highest number of all the formats quoted. A similar search carried out in December 2019 showed that there were 477 active ingredients listed as being formulated as an emulsifiable concentrate.

Of course, this only relates to the number of active ingredients and not necessarily the value of the formulation type. In 2017, Matthew Phillips (then of Phillips McDougall) presented data³ which showed the market value of different formulation types between 1992 and 2014. Whilst EC was the most valuable formulation type in 1992 with 35% market share, the share had dropped to just over 25% in 2014, but it was however still the most valuable formulation type. As part of an forthcoming report⁴, we recently accessed the Agraspire database⁵ from 2018 to look at the share in value of the various formulation types and again found that EC still represented a large proportion of the

value of products sold with the 23% market share just being below the 25% represented by sales of Suspension Concentrates (SC) formulations.

So why have we not seen the demise of the EC formulation? There is no single reason for this but we have speculated on a number of the possible explanations.

Firstly, the solvents have evolved and even with the Solvesso types the use of naphthalene depleted (ND) grades has become commonplace and this allows these grades and normally formulations not to require the H351 hazard statement “suspected of causing cancer”. Looking at one of the more popular herbicides, formulated as an EC, namely clethodim, we can see that new products such as UPL’s Shadow[®] 3EC still includes a heavy aromatic naphtha solvent (CAS 64742-94-5) but with a low level of naphthalene so is likely to be using a naphthalene depleted grade.

Of course, there have also been a number of new “greener” solvents coming onto the market which have claimed to be equivalent to the traditional solvents. One of the earliest families to be promoted for this application was the Rhodiasolv[®] range now being sold by Solvay, but there are also products such as the Armid[®] family from Nouryon, Corbion’s Purasolv[®] range and vegetable oil methylated esters from companies such as Croda to name but a few. To promote their equivalence to the more traditional solvents, the use of Hansen Solubility Parameters (HSP) is often used and this approach does demonstrate the technical feasibility of using these solvents but cannot cover other aspects such as level of active ingredient, emulsifiability and perhaps most importantly cost. This cannot be underestimated as the main EC products are all large volume - with many out of patent - so margins will be tight. Unless there is a regulatory requirement to remove heavy aromatic solvents then the cost of a new solvent must be close to that of the traditional solvents.

A further indication that this formulation type will still be with us for a long time is the research activity as measured by academic and patent literature. As a further part of our work on the new report we found 21 WO patents in the main AO1N category which covers agrochemicals and included “Emulsifiable Concentrate” in the title or abstract and published since January 2016. Similarly, a search for the term in the title or abstract of academic literature yielded 26 results. So, whilst this is not the most active area for research in agrochemicals, it is certainly far from dead.

In summary, reports of the death of the Emulsifiable Concentrate are not to be believed and this is, and will remain, a valuable and significant formulation type due to its wide applicability, technical efficacy and cost effectiveness.

Reference:

1. <https://cipac.org/index.php/methods-publications>

2. *Agrow Formulations 2016 (Informa Agrow)*

3. *Matthew Phillips Presentation at Informa Crops and Chemicals in Berlin 2017*

4. *Agribusiness Intelligence: Agrow Formulations 2020 (to be published)*

5. <https://agribusinessintelligence.informa.com/products-and-services/data-and-analysis/phillips-mcdougall/agraspire>

Eurofins Advinus: Challenges and Criticality of Analytics for Ecotoxicology Studies



Krithi Shetty B.

Eurofins Advinus Limited

Key analytical requirements for dose formulations to comply with GLP

The dose formulations (test item in the vehicle) prepared for dosing the test systems in toxicology studies are required to be analysed for test concentration verification. The dose formulation preparations need to be checked for their concentration, stability and homogeneity.

Common practice for developing analytical methods

The usual practice is to develop an analytical method covering the concentration range of the dose preparations that are used in the toxicology studies. It is recommended to cover at least 30% lower side of the low dose concentration and at least 10% higher side of the higher dose concentration so as to further cover analytical or preparation variations. After the developed method is validated, this method is used for testing the stability of the preparation. If the preparation is a suspension or dietary, homogeneity is also need to be tested. Based on the stability of the preparation, frequency of preparation of the dose formulations will be decided.

Challenges of analytical methods meant for Ecotoxicology studies

In case of ecotoxicology studies, for example fish toxicity studies, the dosing happens through introducing the test item into the test medium (water, reconstituted water, etc.). Depending on the stability of the test item in the test medium, whether to conduct the study under static conditions or semi-static conditions will be decided. Under semi-static conditions, the test medium is changed, after a period not less than 24 hours, with freshly fortified (with test item) test medium. The frequency of changing the fortified medium under semi-static conditions is decided based on the stability of the test item in water. It is believed that changing test medium at a frequency less than 24 hours can introduce

stress on the organisms. Hence, for semi static conditions, the stability requirements will be 24 hours and for static conditions the stability requirements will be up to the end of exposure period (e.g., 96 h, 48 h). There are test items which are not stable in the test medium even for 24 hours. In such cases, the actual analysed concentrations in the test medium at various intervals, as it degrades, till 24 hours will be used for interpretation of the ecotoxicity study results. This means that, it is not enough if the concentration range of the analytical method covers just the initial dose concentrations. The method need to be able to cover concentration of test item present in the test medium, as it degrades during the study, even at the end of the 24-hour period. This means that the Limit of Quantification (LOQ) of the method needs to be several folds lower than the lower dose concentration.

The dose concentrations used in ecotoxicology studies, most of the times, run into ppb and ppt levels. But if the test item is not stable in the test medium for even 24 hours, the concentrations to be covered in the analytical method further get lowered, to be able to analyse the concentrations as the test item degrades in the water over 24-hour period.

Strategies to overcome challenges

To overcome major challenges of analytical methods for ecotoxicology studies, a GLP test facility requires analytical techniques that allow very very low LOQs and a team of experienced analysts to develop and validate methods. Various techniques like, highly sensitive LC-MS/MS and GC-MS/MS are usually used for such analysis, but even these need to be higher-end equipment in order to analyse samples at such lower concentration levels, in spite of concentrating the samples by extracting the test item into volatile solvents or by SPE methods.

The analytical methods for supporting ecotoxicology studies hence become very trying and require enormous analytical expertise to develop methods and to use high-end analytical

instrumentation for validation and sample analysis. Further, when working at such low concentration levels, contaminations resulting in ghost peaks or interferences become major problems.

In cases where test item solubility in the water is negligible, the test item is mixed with water thoroughly by physical means (sonication, magnetic stirring, etc.), filtered / centrifuged and the resultant test medium is used in the study. This also makes the analytical method development and validation much more complicated.

Stringent and meticulous efforts are made to solubilize test item using physical and chemical aids (carriers) so that a stable and uniform dispersion of test item is achieved in the test medium. Use of carriers is the last resort for introducing a test item into test medium. In such cases, test item concentrations in test medium are solely dependent on the analysed concentrations.

Overall, the analytical results of the dose preparation analysis become very important part of the ecotoxicology studies and any uncertainty in these analytical results seriously impact the outcome of the entire ecotoxicology studies.

What makes Eurofins Advinus to overcome challenges

Eurofins Advinus is specialized in analytical services for ecotox studies, equipped with well trained and experienced personnel; and top-end analytical equipment like, high-end LC-MS/MS, GC-MS/MS, ICP-MS, etc. Further the analytical sample processing labs for these analyses are well separated from the other routine analytical labs so as to avoid any contamination. Even the glassware used for this purpose are dedicated only for ecotox analytical purpose including a dedicated glassware cleaning area. Analytical expertise at Eurofins Advinus includes developing such methods for analysis at extremely low concentrations for test items containing multiple analytes and also for those unstable in the test medium. Thorough validation of these methods including the matrix effects, qualifier ions in MRM for better specificity, etc., are conducted prior to using them for the study sample analysis, as this become essential for getting reliable analytical results.

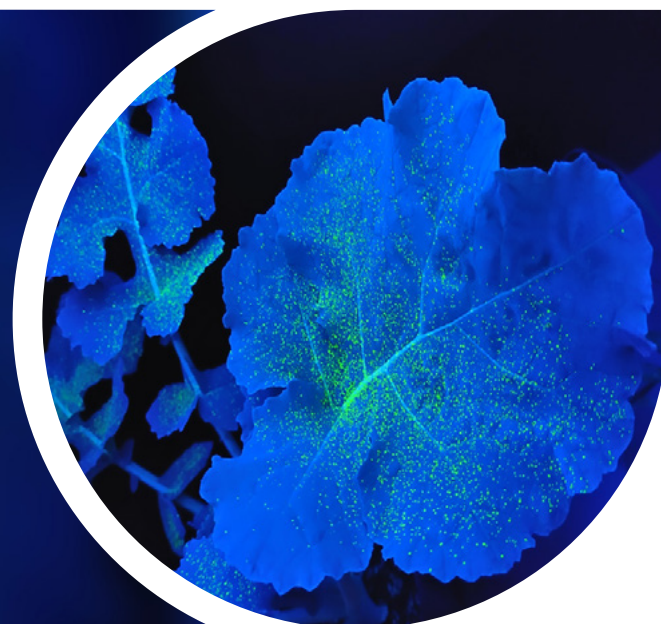
Conclusion

Development and validation of analytical methods for ecotoxicology studies are several folds more complex and challenging than those applicable for general animal toxicology studies. Claiming laboratory competence for performing such studies requires not only high-end analytical equipment but also trained people dedicated to generate data for meeting global regulatory requirements.

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Nouryon: A New Biodegradable Polymeric Dispersant for Crop Protection Formulations



Dr. Mojahed Islam

Senior Scientist at Nouryon, USA

Regulations play an important role in formulation design and available technologies. Some of the versatile tools like Nonylphenol ethoxylates (NPE), N-Methyl-2-pyrrolidones (NMP) have been banned and authorities have a list of substances they continuously evaluate. Recently, European Chemical Agency (ECHA) has been evaluating styrenated phenol. Based on available information and screening data, styrenated phenol meets the criteria for very bioaccumulative (vB), persistent (P) and possibly very persistent (vP) in the environment. ECHA states that the substance has also the potential for endocrine disrupting properties and is investigating which may affect tristyrylphenol derivatives and their use in crop protection formulations.

ECHA has also submitted a restriction proposal for microplastic particles that are intentionally added to mixtures used by consumers or professionals. The persistence and the potential for adverse effects or bioaccumulation of microplastics is a cause for concern. Derogations are proposed for polymers that occur in nature, polymers that meet criteria for minimum (bio)degradability which makes (bio)degradability an important property in selecting formulation aids in crop protection formulations.

Dispersancy is an important functionality in retaining physical stability of formulations which in return enhances bio-efficacy. Typical dispersing agents are surfactants and/or polymers. For a good dispersant, adsorption efficiency to solid substrate (AI) is an important criterion. It is known that polarizable aromatic groups in the hydrophobe of a dispersant can provide good substantivity to the actives. Thus, dispersants based on tristyrylphenol (TSP) or nonylphenol (NP) are commonly used and show good efficiency. Unfortunately, these types of chemistries, as noted, are under regulatory scrutiny. Thus, there is a need to develop sustainable dispersing agents.

In addition to efficient adsorption, the surfactant molecules need to provide either electrostatic or steric stabilization (ideally both) to function as a good dispersant. Thus, anionic surfactants



Dr. Turgut Battal

Global Technical Marketing Manager at Nouryon, Sweden

are most commonly used as primary dispersant and due to the versatility of ethoxylated phosphate ester, this type of chemistry is used extensively. Advantage of this type of chemistry is that it is highly tunable. One can do that by selecting different hydrophobes (linear, branched, saturated and unsaturated), as well as degree of ethoxylation. Phosphate esters are prepared by reaction of an alcohol with either polyphosphoric acid or phosphorus pentoxide. Using phosphorous pentoxide results in formation of both mono and diester, which is desirable, since presence of diester is important for dispersion (see Table 1 below).

Property	Mono-ester	Di-ester
Hydrotropic	Excellent	Poor
Electrolyte tolerance	Excellent	Poor
Wetting	Good	Fair
Emulsification	Good	Good
Foam	High	Lower
Dispersing	Poor	Excellent

Table 1. Impact of ester distribution on the performance

In the search for a versatile and sustainable dispersing agent for crop protection, a series of surfactants were synthesized and evaluated by varying the hydrophobe as well as degree of alkoxylation, with the following desired outcome:

- Performance equivalent or better in a wide range of actives compared to current leading dispersants
- Non endocrine disruptor
- Biodegradable
- Low eye irritation
- Low aquatic tox

Our assessment has showed that shorter hydrophobes are preferred for biodegradability, but unfortunately shorter hydrophobes generally result in poor performance. Propoxylation (PO) of the molecule in addition to ethoxylation (EO) mitigated the

issue. However, even with presence of PO, there is a limit to the size of the hydrophobe. In addition, branching of the hydrophobe was found to be important. Molecules with branched hydrophobe resulted in SC's with desirable stable viscosity. Thus, optimizing the molecule in terms of size of the hydrophobe, degree of propoxylation and ethoxylation as well as reaction route resulted in Agrilan 1015, a biodegradable dispersant that performs as well or better than TSP based dispersant and had improved toxicity profile.

Biodegradability of Agrilan 1015 as well as a competitor product based on Ethoxylated TSP-phosphate ester (TSP-PE) was also evaluated. The Figure 1 below shows the comparative data. Both Agrilan 1015 and TSP-PE contain propylene glycol and the initial sharp rise in biodegradation is due to the presence of propylene glycol. Comparison of the data clearly shows Agrilan 1015 continues to biodegrade even after 12 weeks, whereas for TSP biodegradation levels out after three weeks and most of the degradation is due to propylene glycol. Thus, Agrilan 1015 can be designated as inherently biodegradable and not persistent, whereas TSP is almost non-biodegradable and persistent.

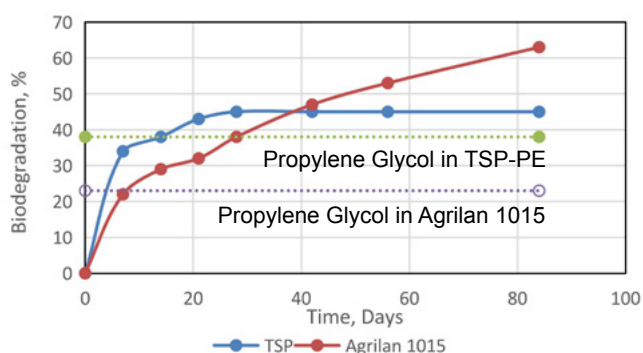


Figure 1. Percentage of biodegradation of Agrilan 1015 and TSP-PE by activated sludge. The horizontal line represents the percentage achieved upon complete degradation of propylene glycol.

Evaluation of Agrilan 1015 in SC formulations was carried out using various actives and was compared to a leading commercial dispersant based on TSP (TSP-PE). The formulation used to prepare these SC's is shown in Table 2. All SCs were subjected to two weeks stability at elevated temperature (54°C). Evaluation of the SC properties showed that the new dispersant, Agrilan 1015, afforded similar or better performance to the commercial dispersant (an example data for suspensibility is shown in Figure 3). Figure 2 shows a comparative picture between Agrilan 1015 and TSP-PE after two weeks storage stability at 54 °C .



Agrilan 1015 was also tested in seed

Figure 2. Stability comparison between Agrilan 1015 and TSP-PE after 2 weeks storage at 54 °C

treatment formulations, particularly for FS and showed excellent performance that resulted in high color saturation for selected pigments.

Ingredient	g/L
Active	200-300
Morwet EFW (wetting agent)	20
Agrilan 1015 (% active)	25
Ethylene Glycol	50
Defoamer	2
Xanthan Gum	1-2
Water	balance
Total	1 L

Table 2. SC formulation used for evaluation of Agrilan 1015 and TSP-PE

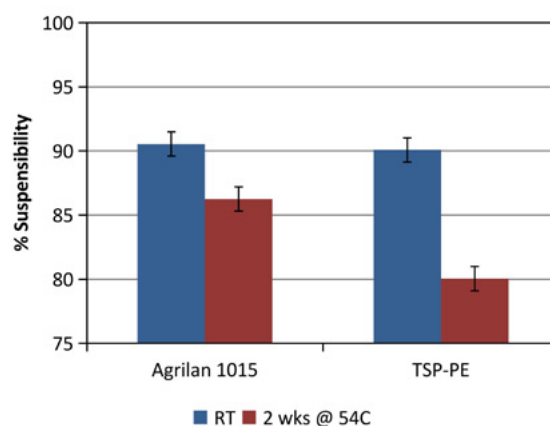


Figure 3. Suspensibility of Diuron SC afforded by Agrilan 1015 and TSP-PE after milling (RT) and after accelerated aging

In addition to testing Agrilan 1015 as a formulation aid, surfactant properties (surface tension, CMC and wetting) were evaluated (Table 3). Agrilan 1015 exhibits lower surface tension and better wetting than TSP-PE. Better wetting implies that Agrilan 1015 could be used as wetting agent. To validate this assumption, an SC of Azoxystrobin was prepared without the use of any wetting agent. Figure 4 shows the particle size distribution attained after milling for 15 mins and it is well within the desired limits.

	CMC, mg/L	Surface tension at 0.1 wt%, mN/m	Draves wetting at 0.13 wt%, sec
Agrilan 1015	68.5	32.8	17
TSP-PE	9.6	43.5	310

Table 3. CMC, Surface Tension and Draves Wetting data for Agrilan 1015 and a commercial dispersant based on TSP

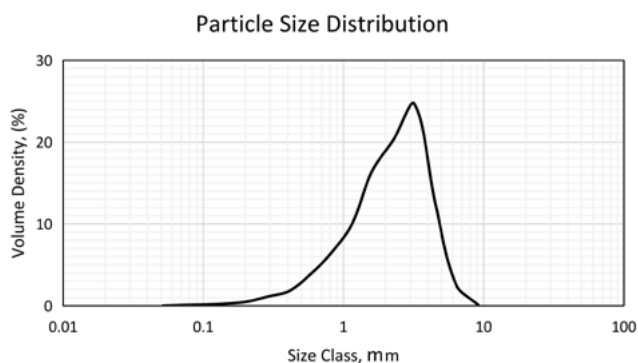


Figure 4. Particle size distribution of Azoxystrobin SC without the use of any wetting agent

Eye irritation of Agrilan 1015 was also evaluated using an *In Vitro* method (Bovine Corneal Opacity and Permeability, BCOP). An *In Vitro* score of significantly less than 3 indicated that this product is non-irritating. In addition, aquatic tox was also assessed using an in-house “Algae growth inhibition” method. The results indicate that this product is not expected to be acutely toxic to aquatic organism.

In summary, Agrilan 1015 is a new biodegradable dispersant for aqueous systems, such as SC and FS. It offers low toxicity with ‘clean’ label-contains no classified ingredients. It is designed by a unique patent protected technology. In addition, it can be used as wetting agent and an emulsifier in EW and SE formulations.

Some additional information



Figure 5. Picture of Agrilan 1015

Characteristics

- Appearance: Clear Liquid
- Viscosity: Pourable
- Solid Content: 50%
- pH: 5.5-6.5

Regulatory Status

- TSCA and FIFRA listing under consideration
- Meets REACH polymer exemption
- Listed in China and Japanese Chemical Inventory

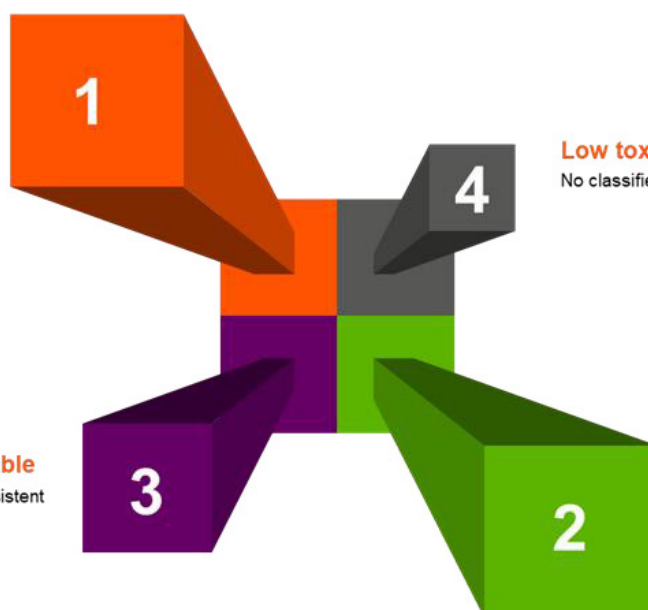
Agrilan® 1015

Liquid dispersant
For crop protection, including seed treatment formulations

Biodegradable
And non-persistent

Low toxicity
No classified ingredients

Emulsifier and wetting agent
For SEs and EWs, low foam





Helping feed the world

Caring about things like soil, crops, and animals is your core business.
Enabling you to grow is ours.

We combine our cutting-edge technologies and unique know-how with your skills and expertise as a provider of products to the agricultural market. We provide building blocks for producing fungicides and herbicides as well as adjuvants and formulation aids.

Agrilan® 1015 is the latest product from Nouryon — a biodegradable polymeric dispersant for crop protection formulations.

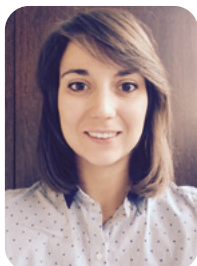
Our agrochemical product line includes well-known brands such as **Morwet®** dispersants, **Adsee™** adjuvants, **Agrilan®** polymers, **Armid®** solvents.

Contact us at agro@nouryon.com or visit our website nouryon.com/agriculture.

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Solvay: LIFE STIMUL Project – Yield Performance and Environmental Benefits of a Novel Biostimulant Seed Coatings



Clara VERNAY
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STIMUL Project Member



Jean-Christophe CASTAING
R&I Manager at Solvay, LIFE
STIMUL Project Leader

Ecological considerations, along with economic and environmental demands, are key drivers that continually challenge farmers to improve agriculture practices and techniques. Farmers must adopt the most profitable practices possible to generate higher crop yields, while using fewer chemicals and at lower toxicity levels. Ecological considerations have given rise to growing crops using new methods, such as integrated pest-management systems and precision agriculture. These new methods help strike a balance between the economic constraints prevalent in today's market and the moderate use of plant-protection products, fertilizer and irrigation inputs.

With this in mind, over the past few years, Solvay has developed a range of bio-based, seed-applied biostimulants under the trade name AgRHO® S-Boost™. Derived from a natural agropolymer extracted from a legume plant, AgRHO® S-Boost™ provides demonstrated benefits in terms of water and nutrient uptake of the plant that results in higher yields. Solvay's bio-based biostimulant helps the plant thrive under various abiotic stress factors, such as drought, extreme temperatures and high winds, all of which can considerably reduce crop quality and yield.

Prior to the STIMUL project launch, data were still missing on how to leverage this innovation under conditions resulting from low-input cultural practices in order to reduce the environmental footprint by limiting fertilizer inputs and water consumption. Also, to grow this technology within the seed industry, it is critical to develop efficient and safe application recipes for products adapted to existing seed-plant technologies.

Funded by the European Commission (LIFE program), STIMUL (Seed Treatments to keep Inputs at Minimum Use Level) is a project led by Solvay in collaboration with Aegilops Applications, a French SME (small and medium-sized enterprise) that is globally engaged in design and production of coating agents applied

with seed treatments. The objective of the project is to generate field data to demonstrate that innovative biostimulants will give farmers the opportunity to significantly reduce fertilizer use and/or water consumption while maintaining the same level of yield.

Since 2016, in the framework of the LIFE STIMUL project, field trials have been conducted in different European countries to evaluate the agronomic performance of Solvay biostimulants. Field trials have been performed on various crops, including corn, soybean, wheat, rapeseed and sunflower. A high number of trial locations have been selected annually to assess the biostimulant performance in different conditions: climatic zones, soil type, crop variety and agricultural practices and techniques. The trials were performed using randomized complete block design in four replications for each tested product. Different notations were recorded during plant development to assess plant growth and final yield at standard moisture. For each trial, the plot was divided in two regions. One was managed with standard farming practices (e.g. standard nitrogen fertilization input), while the other corresponded to low-input farming practices (e.g. a 30% reduction in nitrogen fertilization input). This setup enabled Solvay to evaluate whether the biostimulant treatment could compensate for the yield loss triggered by low-input farming practices. Field trial results were computed and analyzed with agriculture research management (ARM) software. Statistical tests, specifically least significant difference (LSD) testing, were conducted to study the significant differences between groups. Results were considered significantly different when $p < 0.05$.

Together with its partner Aegilops Applications, Solvay tested different variants of the AgRho S-Boost™ range. The effects of the biostimulant treatment on grain yield are presented in Figure 1 for corn and Figure 2 for soybean. The biostimulant was applied at two dosage rates: 0.2 kg/qt and 0.3 kg/qt of active ingredient on seeds. The results presented in Figure 1 and Figure 2 correspond to consolidated results encompassing three years of field trials (2017-2019) conducted in four countries (France, Italy, Hungary and Romania) for corn and three countries (France, Italy and Serbia) for soybean. For both crops, these countries rank in the top four of European producers of grain maize and soybean (based on 2017 data). In total, 56 trials were conducted on corn and 48 trials on soybean.

For corn, the biostimulant at the lower dose rate (0.2 kg/qt) triggered a relative yield increase of +2.7%, whereas a relative increase of +2.8% was observed at 0.3 kg/qt. Both increases are statistically significant, compared to the control treatment. Hence, the biostimulant applied at 0.2 kg/qt and 0.3 kg/qt significantly increased corn yield, compared to the untreated check. The two dosage rates did not show any difference in terms of performance. Stable performances were observed from 0.2 kg/qt to 0.3 kg/qt.

Similar outcomes were observed for soybean results, as presented in Figure 2. The biostimulant treatment at 0.2 kg/qt triggered a relative gain of yield of +2.7%, while a yield increase of +3.0% was obtained at 0.3 kg/qt. As for corn, these two relative increases are statistically significant. In conclusion, the Solvay biostimulant applied at 0.2 kg/qt and 0.3 kg/qt on soybean seeds triggered a significant yield increase, ranging from +2.7% to +3.0% of relative increase.

The Solvay biostimulant modified the plant environment and metabolism, increasing root architecture by densifying secondary roots. This phenomenon was demonstrated at the laboratory scale with model experiments, as well as with field trials. Figure 3 shows observations made during the visit of a field trial on corn in Italy in 2018. The picture on the left shows a corn plant not treated with the biostimulant, while the picture on the right shows a corn plant treated with the biostimulant. Both clearly show that the biostimulant strengthens root development and maximizes plant establishment. Such a developed roots network enables an increase in nutrient and water uptake by the plant, and ultimately increases yield.

For the field trials conducted on corn, standard- and low-nitrogen input practices were compared to assess how fertilizer inputs might be able to be compensated by the use of the biostimulant seed treatment. Since 2017, 10 comparisons between full-nitrogen inputs and low-dosage rates of nitrogen (ranging from -30% to -50%) were conducted. Consolidated results are presented in Figure 4. When averaged over the

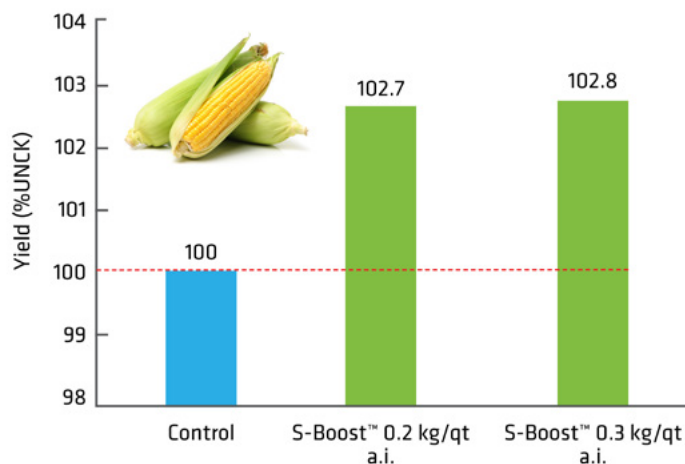


Figure 1. Field trials results on corn (STIMUL project, 2017-2019)

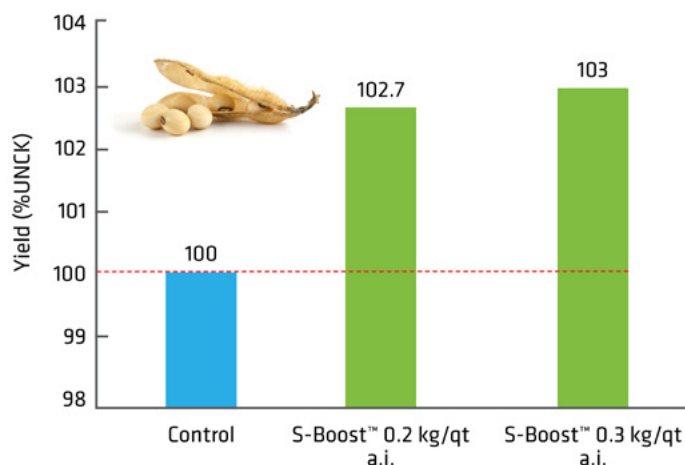


Figure 2. Field trial results on soybean (STIMUL project, 2017-2019)



Figure 3. Influence of Solvay biostimulant on the root system

different trials, nitrogen inputs were reduced by 41%, triggering a relative yield loss of -10% for the untreated check. The addition of the biostimulant seed treatment compensated for a yield loss of 31%. Hence, we could estimate that the biostimulant seed treatment could entirely compensate for a 13% reduction in nitrogen inputs.

STIMUL has demonstrated and quantified with a unique set of data that biostimulants can be used not only to optimize crop yield, but also as new levers allowing a decrease in agricultural inputs. Data consolidated in the last three years through the LIFE STIMUL project demonstrated a yield increase between +2.7% and +3.0% depending on the crop. Those data have been collected with biostimulants from the S-Boost™ range. With its partner Aegilops, Solvay demonstrated that the biostimulant offers the opportunity to significantly reduce fertilizer use while maintaining the same yield.

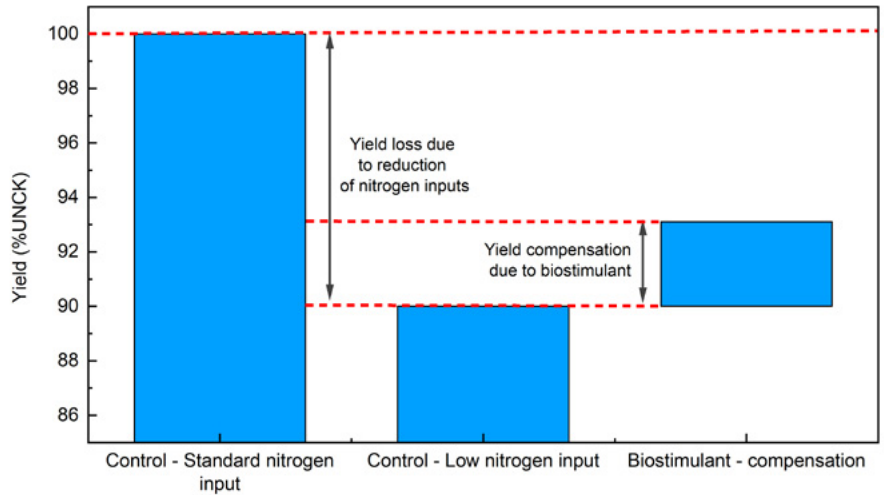


Figure 4. Biostimulant seed treatment to compensate for the reduction of nitrogen inputs



LIFE STIMUL - LIFE14 ENV/FR/000493

The LIFE STIMUL project is co-financed by the financial instrument of the European Union LIFE



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LIFE STIMUL: Improving yield performance and generating environmental benefits with a novel biostimulant seed coating



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Data consolidated in the last three years demonstrated a yield increase between +2.7% and +3.0% with AgRHO® S-Boost biostimulant seed coating depending on the crop. This yield increase could entirely compensate for a 13% reduction in nitrogen inputs.

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Borregaard's Sustainable Agri Solutions

Frédéric Bierre

Business Director Agri at Borregaard Biopolymers



Sustainability is a relative and not always well-defined concept. It is used by many companies these days to claim that their product is more sustainable than others based on differences or criteria that may not always be meaningful.

Sustainability is a key component of Borregaard's business model and one of its core values. The company offers bio-based products with good climate and environmental properties that can replace many petroleum-based products.



Borregaard has been commended for its climate action, achieving a place on global environmental impact non-profit CDP's prestigious 'A List' for climate change, based on the company's climate reporting in 2019. Borregaard is one of 8,400 companies reporting to CDP last

year, only 179 of these made the climate change 'A List'. This is Borregaard's second year on CDP's 'A List'.

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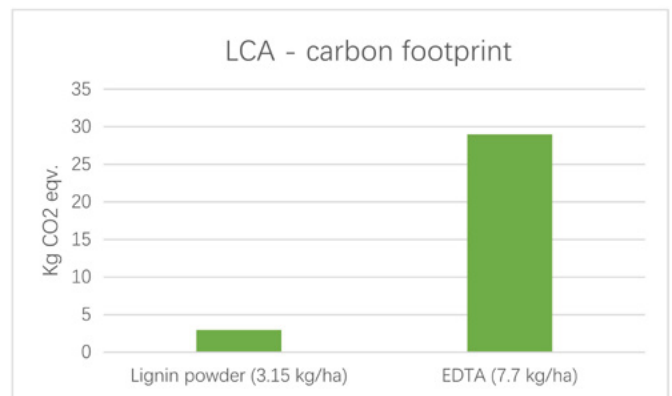
We use 2nd generation bio-based raw materials which means our products are not obtained from materials or lands that can be used for food.

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Finally, the properties and performance of our products can help to make Plant Care Products more efficient and less harmful for the people and the environment.

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- Our Lignin based **Dispersants** can help avoiding compatibility problems in tank-mix and nozzle blocking during spraying which makes the use of Plant Protection Products safer for the users.
- Our **Dispersing agents** can be used when re-formulating powder products into less dusty granulated alternatives and for production of water-based suspension concentrates instead of solvent-based.
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Evonik: Sophorolipid as Novel Adjuvant Technology



Dirk Steinbeck

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The agricultural market is under increasing pressure as consumers prefer food containing lower, or no amounts of residual chemicals, but at the same time growers need to prevent the development of pathogens and pests resistant to active ingredients. Regulators demand less agrochemical input, so the efficiency of agrochemicals has to be improved. Surfactants provide a versatile solution.

Well-known in the agrochemical market, surfactants are used in formulations and as tank-mix adjuvants. The benefits of surfactants are important in plant protection products from pesticide formulation to storage, tank-mix dilution, spraying, targeting and finally acting on the pest. In water-based formulations one of the main tasks of surfactants, also called adjuvants, is to decrease surface tension. This results in better wetting of e.g. surfaces of to be dispersed particles of actives. In oil-based formulations, emulsification properties of surfactants ensure higher stability and lower droplet size. In tank-mix dilutions for all kinds of formulations, surfactants prolong the physical stability as they reduce the interfacial tension between water and the dispersed active ingredients. Targeted delivery is the main purpose of surfactants during spraying, which enhances efficacy and decreases the active amount needed. Targeted delivery is achieved by: 1) reducing driftable particles, 2) enhancing adhesion and retention of spray droplets on the plant, 3) improving uptake and penetration of active ingredients, and 4) increasing rain fastness.

Accordingly, the agrochemical market increasingly demands innovative additives that are more sustainable. As a consequence, rising regulatory pressure lead to the termination of using some surfactants which came with an unfavorable toxicological profile. Evonik, being

one of the world's leading specialty chemicals companies, pursues a high ambition to develop novel, benign solutions which meet or even surpass the market requirements.

New adjuvants that comply with eco-toxicological, safety and sustainability criteria provide solutions to support the plant protection industry. Sophorolipids represent a new class of biosurfactants that offer several improved benefits and comply with eco-toxicological, safety and sustainability criteria.

BREAK-THRU®SF 420 is a novel sophorolipid-based surfactant manufactured by natural fermentation of rapeseed oil and sugar - a vegetable, non-genetically modified feedstock which is sourced in Europe (Figure 1). The yeast strain used is also a natural microorganism - *Starmerella bombicola*. It is also interesting to note that the low temperature fermentation process consumes relatively low energy. Furthermore, no harmful process auxiliaries are being used and no harmful by-products are generated.

From laboratory development to applied technology, greenhouse trials and field trials: Evonik is permanently conducting broad ranges of scientific analysis and test methods to lead and stay ahead of the technological advancements. One important test to analyze the capabilities of surfactants is a surface tension test which is used to verify and confirm wetting and dispersing capabilities.

Due to the special chemical structure (Figure 4), BREAK-THRU®SF 420 is an

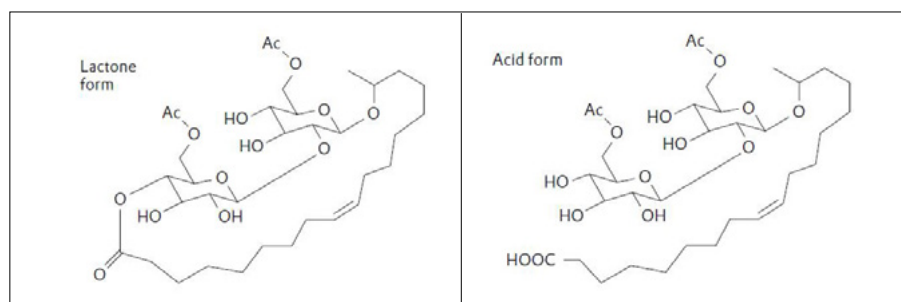


Figure 1. The sophorolipid adjuvant comprises a lactonic uncharged molecule in combination with a charged, open molecule

excellent dispersant for metal hydroxides like $\text{Cu}(\text{OH})_2$ in water which makes it an excellent option for suspension concentrate (SC) formulations (Table 1). The lower surface tension as illustrated in Figure 2, leads to excellent spreading and thus to a more even distribution of, for example, copper spray solution on the foliage, improving the control of fungicides. Furthermore BREAK-THRU® SF420 also increases insecticide performance (Figure 5) and enhances the activity, the speed of action and the duration of effectiveness of herbicides. The ability of BREAK-THRU®SF 420 to disperse metal cations can be also applied for nutrient suspension concentrate (SC).

This multifunctional biosurfactant performs very well as a water soluble, low foaming tank-mix surfactant by reducing the surface tension of water to < 38 mN/m (Figure 2). Accordingly, due to the novel mode of action BREAK-THRU®SF 420 provides excellent adhesion. As proven in a post rain analysis, it delivers significantly higher retention on very difficult to wet species such as wheat: As it dries, a film is formed from the gel layer created by a hydration effect of rainwater and the sophorolipid.

Therefore, a more even distribution of spray solution on the foliage is achieved, resulting in superior rainfastness (Figure 3).

The combined ability to disperse copper evenly, and to provide copper deposition and retention on very difficult and difficult to wet species, make BREAK-THRU®SF 420 a state-of-the-art adjuvant in comparison to existing commercial Cu-formulations.

In greenhouse trials, the efficacy of Naturalis® against whiteflies in tomato was evaluated. The obtained results demonstrate the significant improvement of performance of Naturalis® against whitefly by adding BREAK-THRU®SF 420 at a treat rate of 500 ml/ha (Figure 5).

In addition to its outstanding performance BREAK-THRU®SF 420 provides stability across a wide pH range, and is regarded in general as a benign product, which is also readily biodegradable (> 99 % after 28 days) according to OECD 301 C).

BREAK-THRU®SF 420 has been approved by the German Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (BVL) for use as tank-mix adjuvant for herbicides and fungicides for the German agricultural market.

To conclude, all the features of sustainable multifunctional surfactants innovated by Evonik help increase the biological efficacy of agrochemicals, which has been confirmed in many field applications around the globe.

g/L	Ingredient	Function
383.0	Copper hydroxide	Active ingredient
75.0	BREAK-THRU® SF 420	Dispersing and wetting agent
3.0	BREAK-THRU® AF 9903	Antifoam
3.3	NaOH (20% solution)	Neutralization
2.5	Xanthan gum	Thickener
50	Propylene glycol	Antifreeze
q.s.	Water	Solvent

Table 1. Evonik Cu-formulation; Copper hydroxide 383 SC

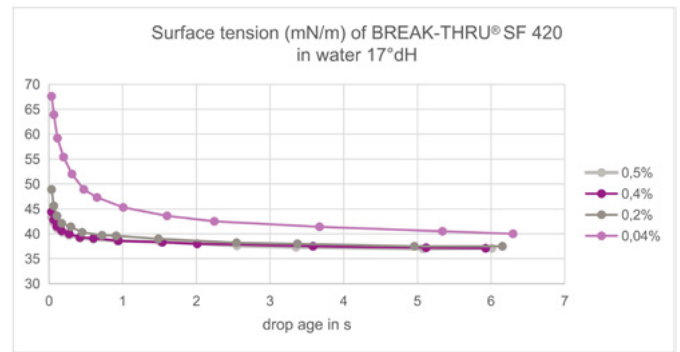


Figure 2. In the discipline to reduce surface tension, the sophorolipid adjuvant delivers excellent wetting and dispersing performance

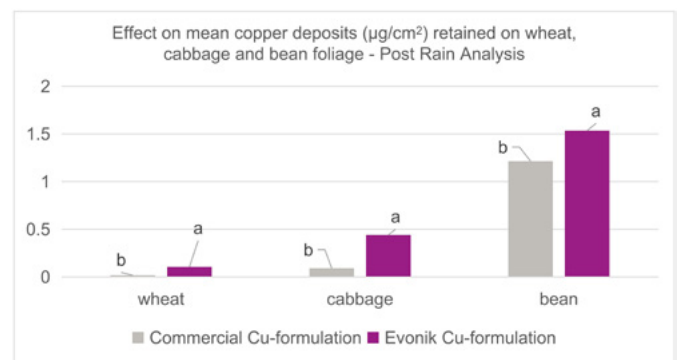


Figure 3. Copper deposit (µg/cm²) retained on wheat, cabbage and bean foliage

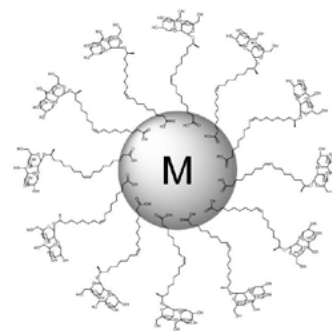


Figure 4. Dispersing of metal(hydr)oxides / carbonates. Taken from: Delbeke et al., Green Chem. Volume 18, (2016), pages 76 - 104

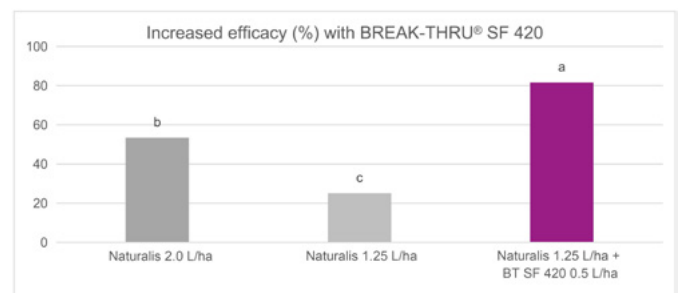
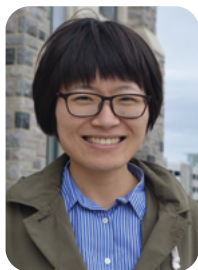


Figure 5. Efficacy of Naturalis® and BREAK-THRU® SF 420 against whiteflies in tomato

Ingevity: Bio-based Adjuvants – The Future of Sustainable Agriculture



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Two of the biggest challenges facing the global agricultural market today are increasingly stringent crop protection regulations and the need to feed an ever-growing population. Farmers have the sizable task of continually maximizing their crop yields, which means it is more important than ever to utilize agriculture techniques and products that can be applied as safely, efficiently and optimally as possible.

To this end, farmers have begun to value agricultural adjuvants for their ability to improve the performance of crop protection and crop nutrient products by enhancing the spreading, penetration and rainfastness characteristics of pesticide formulations. Historically, most adjuvant chemistries are derived from petroleum or other chemical sources, including nonylphenol ethoxylates (NPEs), paraffinic oils, siloxane surfactants and polyglycerolester. With a high manufacturing carbon footprint, the surplus use of these traditional adjuvants in pesticides has the potential to negatively impact the health of humans, animals, fragile biological ecosystems and the environment.

To solve these challenges, pine-based chemistry provider Ingevity developed AltaHance[®], a portfolio of sticker adjuvant products made almost exclusively from renewable resources.

Compared to the toxic nature of conventional petroleum-derived products, AltaHance increases the effectiveness of agrochemicals while providing higher levels of safety and biodegradability. The unique ability of AltaHance technology to offer tunable rainfastness enables additional spreading and penetration benefits, making it a truly multifunctional adjuvant product line.

The value of a multifunctional, eco-friendly adjuvant technology

Growing awareness among the commercial agricultural community of the value of incorporating natural and renewable ingredients in formulations continues to increase the demand for bio-based adjuvants and foster the development of greener solutions for agricultural applications. A multifunctional technology that offers tunable rainfastness and additional spreading and penetration capabilities, the AltaHance product family is designed for use in crop protection products to enhance the effectiveness of the agrochemical.

AltaHance increases the efficacy of the agrochemical while delivering broad compatibility across various solvents and surfactants, as well as excellent stability over wide temperature

Table 1. Basic properties of Ingevity's AltaHance product line

	Viscosity, cp*	Gardner color	Pour point, °C	Boiling point, °C	Flash point*, °C	Surface tension*, mN/m	Rainfastness improvement
AltaHance S	50	6	-4	>185	>150	31.9	Basic
AltaHance 2S	90	5.5	-6	>185	>150	32.2	Medium
AltaHance 3S	245	5.6	-6	>185	>150	32.8	Excellent

*Viscosity: Brookfield, S21 spindle, 25 °C, 50rpm; *flash point: close cup; *surface tension: force tensiometer, RT

ranges and hard water environments. AltaHance products provide the ability to adjust rainfastness at a low dosage rate based on formulation needs, which yields flexibility, easier handling and more robust formulations for agricultural chemical producers. AltaHance can be used as an in-can or tank-mix sticker adjuvant with different active ingredients in various formulation types, including suspension concentrate (SC), emulsifiable concentrate (EC), capsule suspension (CS), solution (SL), suspoemulsion (SE) and more.

Ingevity's AltaHance product offerings are included in Table 1.

All three products have relatively low surface tension (similar to methylated soybean oil). Initial spreading tests on tomato and pepper leaves indicated instant wettability and spreading advantages. AltaHance provides additional penetration properties, which improve the uptake of active ingredients through and into plant cuticles. These test results underscore the multifunctional nature of AltaHance and its ability to provide additional accelerated spreading and improved penetration benefits.

Compatibility with various solvents and surfactants

Although AltaHance doesn't self emulsify, it has impressive compatibility with diverse nonionic surfactants, including ethoxylated distilled tall oil (Ingevity material), sorbitan fatty acid ester ethoxylate, alcohol ethoxylate, nonylphenol ethoxylate and castor oil ethoxylate - which provides flexibility for formulators to select appropriate emulsifiers. AltaHance products have high boiling points and extremely low volatile organic compound content, which ensure product reliability during transportation and user safety. Their sub-zero pour points also make it possible to be used in cold temperatures.

The acid functionality of AltaHance can complex with metal ions, offering excellent performance in hard water. Other challenging conditions, such as cold temperatures (less than 32 °F), impose performance issues for polyterpene-based sticker adjuvants as sub-ambient environments can escalate the formulation's viscosity. In contrast, AltaHance products have excellent cold-water emulsification performance and can be used to improve cold-water emulsification for challenging adjuvant products such as polyterpene. Figure 1 shows improved cold-water emulsification when partially replacing polyterpene with AltaHance S.

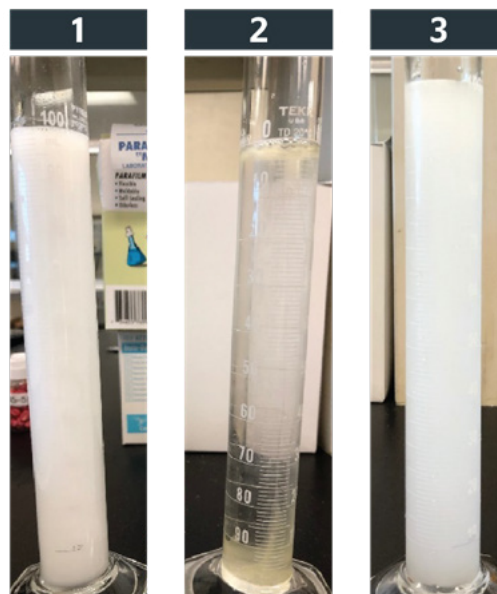


Figure 1. Emulsification of three sticker/emulsifier blends in 32 °F cold water without agitation or inversion. #1: AltaHance S: castor oil ethoxylates (HLB 12.6), 9:1 (wt:wt); #2: Polyterpene: castor oil ethoxylates (HLB 12.6), 9:1 (wt:wt); #3: Polyterpene: AltaHance S: castor oil ethoxylate (HLB 12.6), 6:3:1 (wt:wt:wt)

The unique ability of AltaHance to enable tunable rainfastness

Rainfastness can be customized with the three different AltaHance product offerings: base improvement using AltaHance S; medium improvement with AltaHance 2S; and high improvement with AltaHance 3S. Rainfastness evaluation is based on the American Society of Testing and Materials (ASTM) method STP1579 with minor modifications.

Shown in Figure 2, AltaHance provides a significant improvement in rainfastness for glyphosate SL as a tank-mix adjuvant at a 5% dosage level. Without the sticker, glyphosate SL suffered low rainfastness (1.5% retention). With the addition of AltaHance, the retention increased to 11.3%, 19.7% and 46.0% for AltaHance S, AltaHance 2S and AltaHance 3S, respectively.

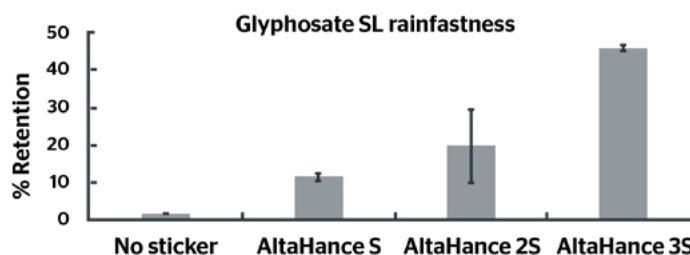


Figure 2. Rainfastness of AltaHance with glyphosate SL as a tank-mix adjuvant.

Figure 3 demonstrates AltaHance 3S used as an in-can adjuvant (1-10% of the total formulation) for a commercial mancozeb SC formulation. After long-term storage tests (54 °C for two weeks and freeze-thaw), the formulations containing AltaHance 3S had minimal particle-size growth and the suspensibility remained unchanged. However, the compatibility of AltaHance for use as an in-can adjuvant must be evaluated on a case-by-case basis.

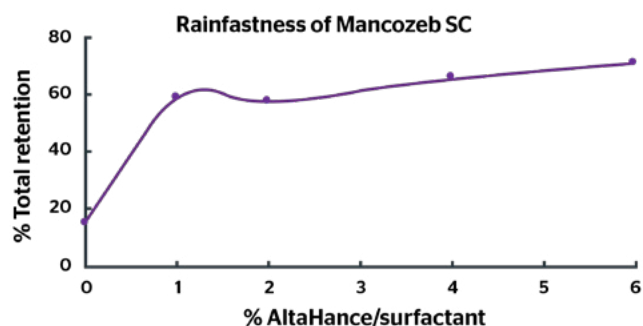


Figure 3. Rainfastness of AltaHance with mancozeb SC as an in-can adjuvant. AltaHance 3S: castor oil ethoxylates, 9:1 (wt:wt).

Table 2 shows AltaHance applied in different formulation types with various active ingredients. Rainfastness improved at a minimum 4% adjuvant dosage in every formulation type with all active ingredients studied. In some cases, tremendous rainfastness improvement was achieved at a 1% dosage rate, as seen in Figure 3. Specifically, AltaHance increased rainfastness by 30-60% in the SC formulation at a 4% dosage rate. This range contained all three AltaHance products with AltaHance S providing base rainfastness improvement (roughly 30%), AltaHance 2S providing slightly more (roughly 45%), and AltaHance 3S (roughly 60%) being the most efficient sticker and providing the highest retention.

Table 2. AltaHance in various formulation types with different active ingredients as a tank-mix or in-can sticker adjuvant.

Formulation types	Actives	%Rainfastness increase at 4% dosage	Tank-mix adjuvant	In-can adjuvant
SC	• Diuron • Imidacloprid • B.thuringiensis • Tebuconazole+ azoxystrobin	30-60	Yes	Yes
SC	• Pendimethalin	30-60	Yes	Yes
SL	• Glyphosate • Micronutrient	10-70	Yes	Yes
EC	• Bifenthrin • Tebuconazole • prochloraz • Azoxystrobin • Gibberellic acid	10-50	Yes	Yes
SE	• Tebuconazole+ azoxystrobin	4-25	Yes	Yes

Anti-leaching capabilities

Leaching can occur when too much pesticide is applied on the crop surface or is carried off the application site into water. AltaHance prevents runoff and leaching by adsorbing into the surface and protecting the pesticide from rainfall. Figure 4 below shows the addition of AltaHance as a tank-mix adjuvant into the diluted pendimethalin EC formulation resulted in more active ingredients residing in the top soil, and overall less leaching out from the soil column.

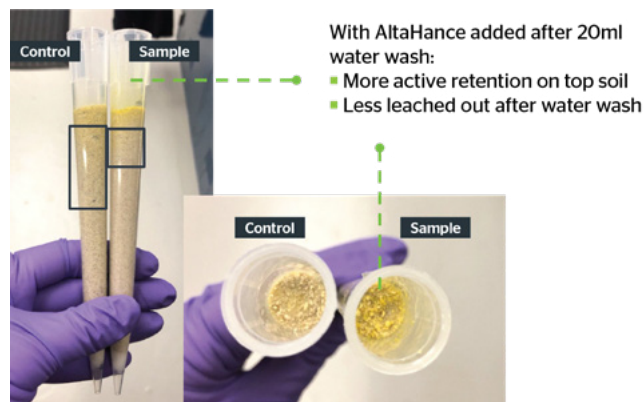


Figure 4. Anti-leaching properties of AltaHance for pendimethalin EC in packed sandy soil.

Achieve the highest crop yield with Ingevity's sustainable adjuvant technology

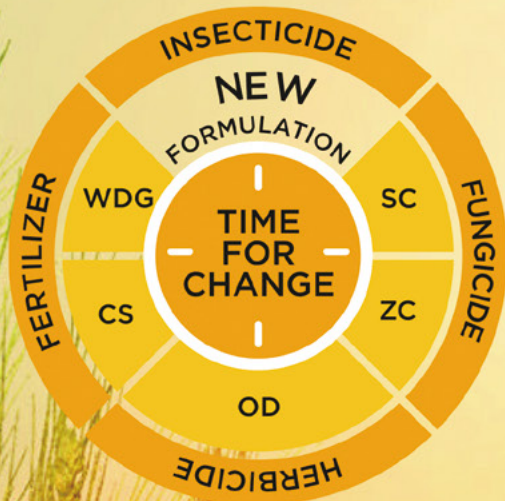
As farmers work to continually maximize crop yields to feed the world's growing population, they look for innovative ways to incorporate renewable products into their pesticide formulations without sacrificing performance characteristics. The incorporation of Ingevity's AltaHance sticker adjuvant portfolio of products into existing crop protection formulations and processes not only provides comparable performance to traditional petroleum-based adjuvant chemistries, but also provides additional benefits, like tunable rainfastness, accelerated spreading, increased penetration, and high performance under challenging conditions. This multifunctional product family is positively impacting the global agricultural market by improving pesticide performance without threatening the environment.



Sulphur mills limited



TECHNOLOGY LEADER IN ADVANCED FORMULATIONS



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Agrovista Expands Marketing of Discovery Spray Adjuvant Range



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UK-based agronomy company Agrovista is accelerating sales of its Discovery range of spray application aids in Europe and beyond, building on its multi-million pound domestic market.

Over the past decade the company has developed and launched several new products under the Discovery brand, mainly in the UK and north-west Europe.

More recently it has expanded into central Europe, Russia, Ukraine and Turkey and the company hopes that growers in France and South Africa will soon benefit from its sector-leading expertise.

The Discovery range is designed to improve the performance of plant protection products. Pesticide efficacy can be reduced by several factors, including poor water quality, poor application as well as inadequate coverage, retention and uptake on the target surface. By overcoming these challenges, Discovery products improve the level of control and increase yields.

Key products in the target geographical regions include Companion Gold, a multi-function adjuvant and pod sealant particularly suitable for use with glyphosate, Remix, a residual herbicide enhancer and Velocity, which improves fungicide application and efficacy across a range of crops.

"Discovery products are an increasingly important part of Agrovista's business, and these three in particular are expected to underpin significant export sales growth over the next five years," says Peter McDonald, Agrovista's Head of Commercial Strategy & Discovery Europe.

"Many leading UK growers use Discovery products to maximize the potential of their agrochemical applications. We have also had a presence for some 10 years in north-west Europe, and two to five years in the target countries. European revenues have the capacity to be five times that of the UK, perhaps more in the longer term.

"We have continued to build our presence across Europe, and have recently taken very sizeable orders in Kazakhstan and Russia. We are also now working with two 50,000+ hectare Agriholdings in Eastern Europe.

"Velocity is now awaiting registration in France, which we hope will happen in the summer, and we plan to submit Companion Gold and Velocity in South Africa, where both products have shown significant benefits on corn and soya bean crops."

Regardless of where they farm, growers face tight profit margins so need

to make use of every tool in the box to achieve maximum yields and returns. "Our Discovery range can deliver significant increases in yield for a relatively modest outlay," says McDonald.

As legislation tightens and pest, weed and disease resistances increase, some active ingredients will disappear while others will be subjected to tighter dose restrictions. "This strengthens the case for using Discovery products – growers need to extract maximum performance from remaining chemistry," says McDonald.

Discovery products are manufactured by Agrovista UK, which can trace its roots back 60 years. The business is part of the international Marubeni Corporation.

"We work very closely with Marubeni in these new markets," McDonald says. "Prospective clients will know we are a reliable and trusted partner they will be comfortable doing business with."



Discovery R&D

Each Discovery product undergoes a comprehensive pan-European R&D program, supported by high quality trials conducted by leading research organizations and universities,

agrochemical manufacturers and Agrovista research and development.

“A key area of our adjuvant R&D focuses on improving application efficacy,” McDonald says. “The trials encompass a wide range of soil types and climates as well as key crops for different areas, such as cereals, maize, oilseeds, pulses, sugar beet, sunflowers and potatoes.”

To ensure maximum performance, Agrovista has designed and developed its own self-propelled sprayers, enabling researchers to test products and methodology under replicated farm conditions.

“We are able to conduct replicated trials that investigate conventional and exploratory application techniques and the interaction with both pesticide and adjuvant.”

In addition, Agrovista works in conjunction with the world-renowned Silsoe Spray Applications Unit to optimize practical spray advice.

Understanding spray application aids and additives

Discovery products have a role to play throughout the spray application process:

Water effects

- Anti foam – reduce excessive foaming by physically bursting air bubbles and reducing surface tension.
- pH buffers – counter high pH in the spray solution that can lead to rapid breakdown (alkaline hydrolysis) of the active ingredient.
- Water conditioners – increase efficacy by deactivating calcium and magnesium cations found in hard water that react with certain pesticides (eg glyphosate).
- Improve spray application by reducing the number of

fine spray droplets (under 100 microns) that are prone to drift.

Foliar effects

Improve coverage by reducing droplet surface tension, lessening bounce and run off from the leaf surface. Better uptake through the leaf's outer wax layers and increased adhesion to the leaf surface, improving rainfastness and weathering of the spray droplet.

Soil effects

Reduce spray turbulence beneath the boom when applying pre- or early post-emergence residual herbicides, improving evenness of spray deposition on soil surface.



Key Discovery products

Companion Gold – multi-function adjuvant and pod sealant

The perfect partner for glyphosate, Companion Gold can also be used as a pod sealant in oilseed rape and legumes.

This multi-function adjuvant is a tallow-amine-free formulation containing a blend of drift-reducing polyacrylamide polymers that offer

class-leading spray drift control.

It contains three types of pH buffers and water conditioners plus antifoam agents to ease sprayer filling and surfactants to improve leaf coverage.

Companion Gold has been proven over many years to significantly enhance the performance of glyphosate.



Remix – residual herbicide enhancer

Designed specifically to improve the performance of residual herbicides, Remix contains a unique blend of highly refined paraffinic oil, hexahydric alcohol ethoxylates and long-chain fatty acids.

The product reduces spray drift and enhances spray patterns and deposition, ensuring the soil surface is evenly coated. Remix also increases the adsorption to soil particles, retaining the herbicide in the upper soil layer. This improves crop safety, weed control and yield.

Over 10 years of Agrovista trials, the addition of Remix to a residual herbicide stack improved black-grass control by 11%.

Velocity – better disease control

Velocity is designed to improve fungicide application and efficacy in a range of crops. It lowers the surface tension of the spray droplet, which reduces bounce and shatter meaning more spray is retained on the leaf.

Organosilicone surfactants ensure complete coverage of the leaf surface, ensuring fungicides are evenly coated to maximize protection against foliar disease, even at lower volumes and higher forward speeds.

Fatty acid methyl esters improve penetration and uptake of fungicide through the outer water-repellent waxy layers of the leaves.

Trials carried out by Agrovista in 2019 at Ilminster, Somerset, UK showed the marked impact that Velocity can have on winter wheat yields. Applying it with a three-way fungicide application at GS39 resulted in an average yield uplift of 0.88t/ha compared to the fungicides alone (Figure 1).

This builds on earlier pan-European evidence from eight fully replicated trials that showed adding Velocity can reduce fusarium levels by half, compared with straight fungicide, when applied at the key early flowering spray timing.

* For further details on Agrovista’s Discovery range, please go to www.discovery-eu.com

Please use author contact details to obtain a user name and password.

Discovery range

- Spray application aids
- Tank-mixed spray additives and adjuvants
- Designed to enhance efficacy of plant protection products
- Targeted formulations, focused by pesticide requirement
- Improved spray application
- Supported by pan-European R&D program
- Comprehensive efficacy data to support use
- Made in Britain

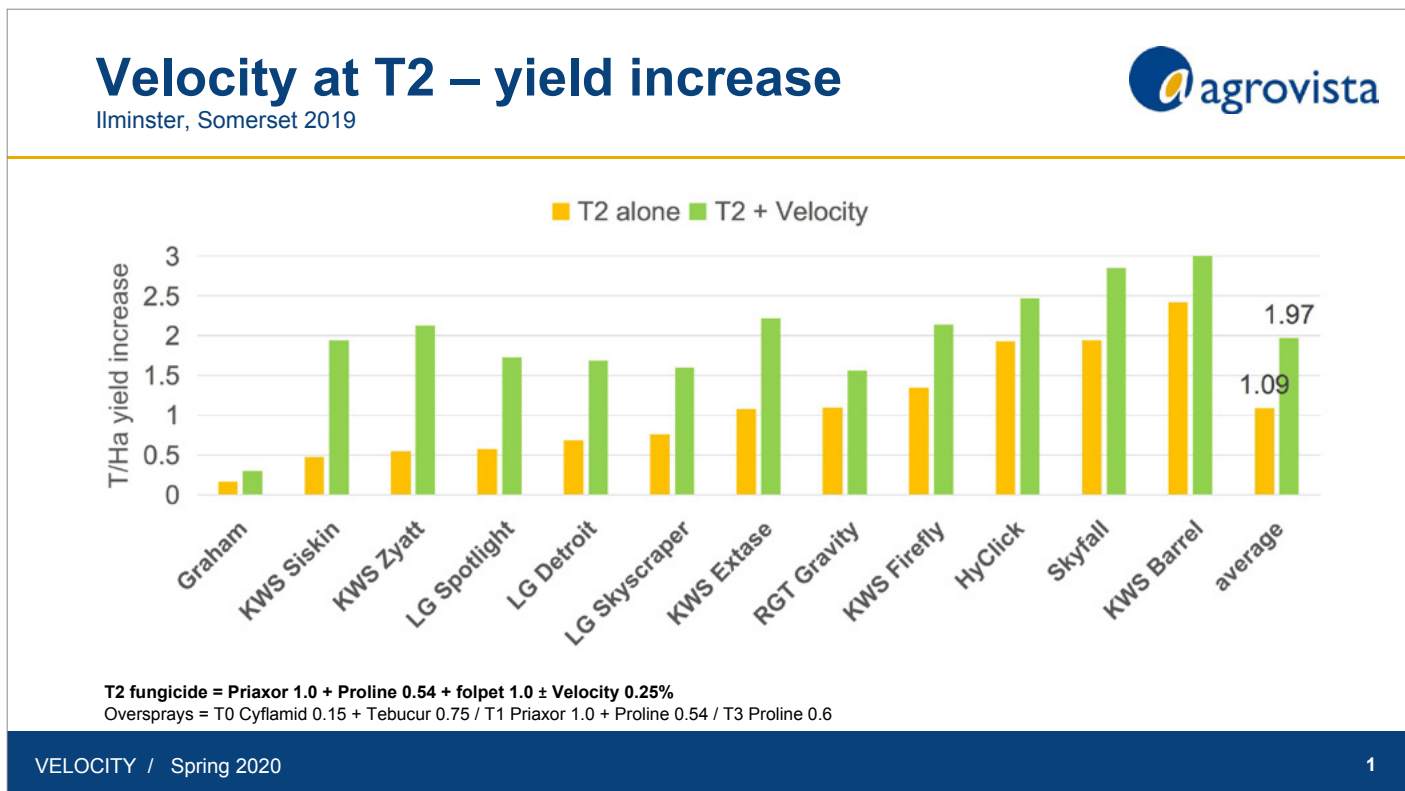


Figure 1. UK Results Velocity at T2 – yield increase



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Dow: Optimizing Emulsion Stability of Solvent and Surfactant Packages Using High Throughput Techniques

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Emulsifiable concentrates (EC) represent a significant fraction of all formulation types applied to the field globally and are valued for their ability to deliver oil soluble actives as well as the ease of transport and storage of the actives. Despite the ubiquitous nature within the crop protection industry, the prediction of oil-in-water emulsion separation time from the multiple structures within the formulation remains limited and drives an experimental approach to development of emulsifiable concentrates. In particular, the presence of various concentrations of electrolytes within the aqueous phase challenges, i.e., hard water, challenge development of a single surfactant package that provides adequately reduced separation time of the oil and water phase from the starting dispersion.¹ Further, surfactant properties are dependent upon the electrolytes present adding to the complicated nature of development of surfactant package for emulsifiable concentrates.

Here, we describe a high throughput experimentation approach that enables development of solvent and surfactant packages that limit the separation of emulsions to <1% after 24 hours at room temperature under various electrolyte concentrations. The approach enables rapid elucidation of the impact of hard water at 3 levels (20, 342, and 1500 ppm CaCO₃ eq.) on a given surfactant package that contains not just a single surfactant, but 3 different surface active agents including an anionic surfactant, a nonionic wetting surfactant, and a nonionic dispersing copolymer.

High Throughput Formulation Preparation

All these formulations are evaluated at constant total surfactant concentration (0.1% (w/w)), but with varying levels of each component. In addition, the immiscible oil phase type are changed, but the oil

concentration remains the same (0.9%). An ABCD design of experiments is used to vary the surfactant concentration amongst the 3 individual surfactants resulting a 10 data point design (plus replicates) for each combination of materials (1 solvent plus 3 surfactants at a given water hardness).

An overview of the workflow to prepare the samples at the 1 milliliter (mL) scale is shown in Figure 1 starting with concentrates of individual surfactants and solvents which are then mixed together at various ratios to prepare the EC using an 8-channel Hamilton Microlab Start liquid handler. The EC is then diluted into water of varying hardness using the same liquid handler, capped by hand, and aged at room temperature. After 24 hours, the extent of separation of the emulsion is determined.

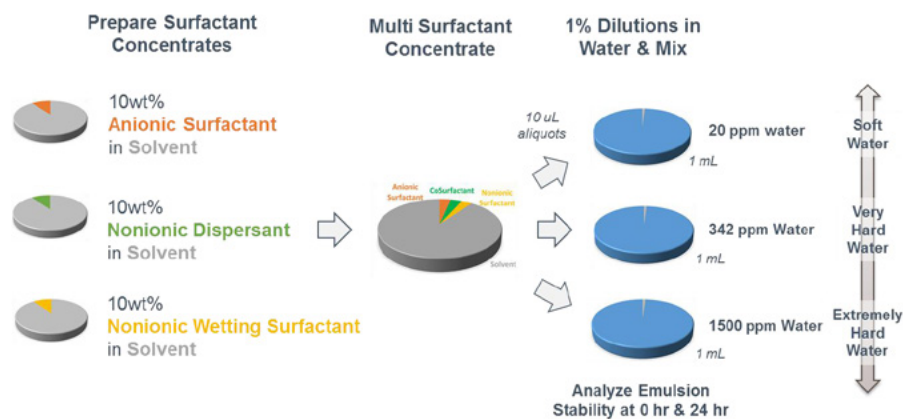


Figure 1. Overview of high throughput preparation process for emulsions

Machine Learning Method to Analyze Emulsion Stability

Determination of the extent of emulsion separation begins with capturing an image of the 1 mL glass vial using a custom-built imaging robot that takes images under well controlled, uniform lighting conditions that remain constant over time. These lighting conditions enable direct spatial and temporal comparison of multiple samples. These images are then analyzed by an in-house developed machine learning algorithm based on human evaluation of a training set of 636 samples and a test set of 158 samples. The confusion matrix of the test set is shown in Figure 2 along with example images of each identified state of the dispersion after 24 hours. Overall, the classification process results in >89% of the images classified into the correct categories.

Effect of Nonionic Surfactant and Dispersant

High levels of water hardness accelerate destabilization of the emulsions due to shielding of the electrostatic repulsion of anionic surfactants. The addition of nonionic surfactants enables use of steric repulsion as a mechanism to slow separation of the emulsion. The extent to which nonionic surfactants are affected by electrolyte concentration is less than anionic surfactants. Thus mixing anionic surfactants and nonionic surfactants enables a blending of approaches in order to achieve limited separation of the emulsion over different electrolyte concentrations in the water.

The example in Figure 3 highlights the effect of nonionic dispersant and nonionic wetting surfactant hydrophilic-lipophilic balance (HLB) on emulsion separation time. The formulation contains 0.9% immiscible solvent in lieu of a traditional aromatic or aliphatic oil with the anionic surfactant, calcium alkylbenzene sulfonate, and a nonionic wetting surfactant and nonionic dispersing copolymer where the sum of the surfactants always equals 0.1%. The nonionic wetting surfactants are secondary alcohol based ethoxylates with the molecular formula of

$C_{11-15}H_{25-31}O[CH_2CH_2O]_xH$ with HLB that ranged from 12.1 to 14.5. The nonionic dispersant copolymers are short chain alkyl initiated alkoxyates with the molecular formula of $C_{2-4}H_{5-9}O[C_2H_4O]_x[C_3H_6O]_yH$ with resulting HLB of 12.5 to 14.5.

As the HLB of the nonionic dispersant increases from 12.5 to 14.5, the operating window of different surfactant ratios that resulted in a stable emulsion, which we define as <1% separation of the emulsion after 24 hours, increased substantially. For example, at the lowest HLB for both nonionic components (12.1 and 12.5), there is no data point that resulted in a stable emulsion. Note, that replication of the 50/50 anionic surfactant/wetting surfactant HLB of 12.1 data shows that 2 out of 3 replicated creamed, but 1 indicated stability.

If the HLB of the wetting surfactant is increased, the number of data points that resulted in stable emulsions is increased only to two points. In contrast, increasing the HLB of the nonionic dispersant from 12.5 to 14.5 increased the number of observed stable emulsion data point to 5 for all values of the wetting surfactant HLB.

The surfactant ratios that result in stable emulsions when the HLB of the nonionic dispersant is 14.5 create a region where the stable emulsion is likely to occur. This region is bound as follows: <67% anionic surfactant, >16% nonionic dispersant, and >16% nonionic wetting surfactant. This trend holds true when the data set for this solvent and anionic surfactant is expanded to include 6 different nonionic dispersant copolymers and 11 different nonionic co-surfactants (not shown).

Future work will continue to advance the capture and machine learning analysis methods to more accurately assess the

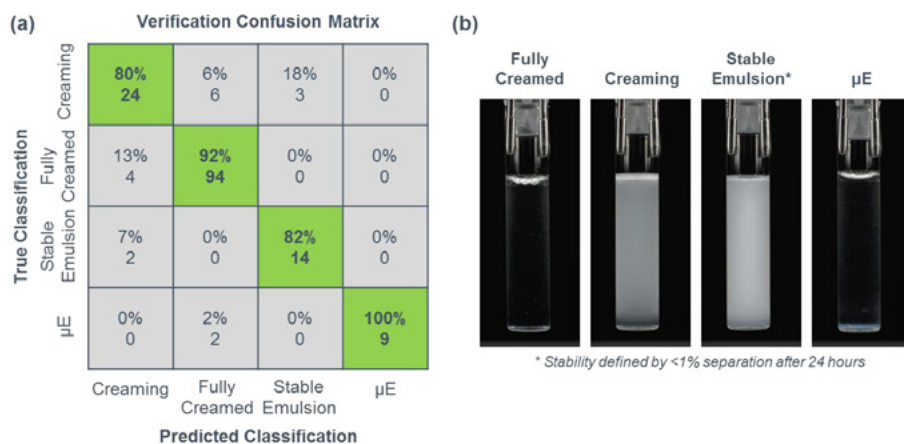


Figure 2. (a) Output confusion matrix of HTR analysis, and (b) example images of each output class

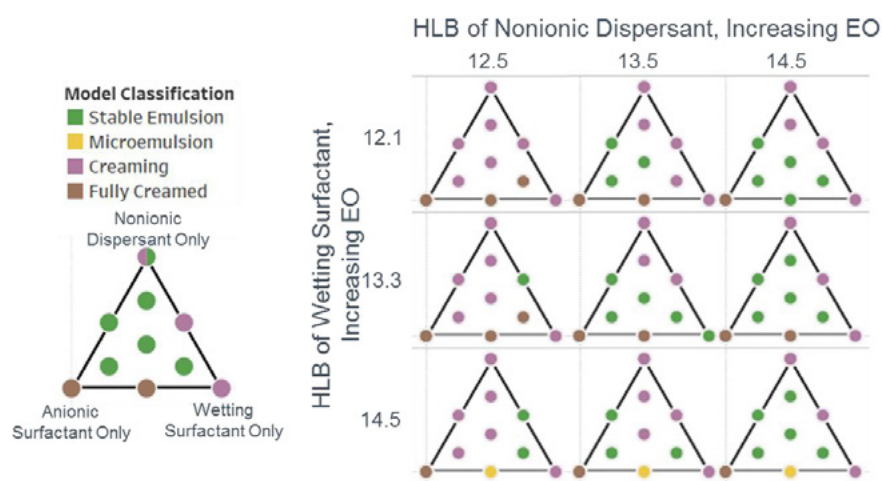


Figure 3. Matrix of output results as a function of HLB of the nonionic dispersant and wetting surfactant at 1500 ppm $CaCO_3$ eq. water hardness

separation of the emulsions over time in order to elucidate structure/property relationships.

Dow materials used here include POWERBLOX™ SV-17 Solvent, TERGITOL™ 15-S-7 Surfactant, TERGITOL™ 15-S-9, TERGITOL™ 15-S-12, TERGITOL™ XJ, TERGITOL™ XD, and TERGITOL™ XH. Visit www.dowcropdefense.com for more information.

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Croda: Approaches to Formulating Biologicals – Challenges and Opportunities

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www.crodacropcare.com

Biological control brings formulation innovation into focus. Concern for the environment, increased demand for healthier foods and difficulties encountered in the chemical control of some diseases of commercially important crops have led producers to seek new, more ecologically appropriate and sustainable technologies. Biopesticides are an example of such technology. These typically fall into the three major classes:

Biochemical Pesticides

- Naturally occurring substances that control pests by non-toxic mechanisms
- Biochemical pesticides include substances that interfere with mating, such as insect sex pheromones, as well as various scented plant extracts that attract insect pests to traps

Microbial Pesticides

- Consist of a microorganism (e.g. a bacterium, fungus, virus or protozoan) as the active ingredient
- Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pest(s)

Plant-Incorporated-Protectants (PIPs)

- Pesticidal substances that plants produce from genetic material that has been added to the plant

The application of biopesticides is still fairly limited to only a few percent of all pesticides used for crop protection. However, biological control holds an important position in integrated crop solutions programs to deliver performance advantages alongside traditional plant protection products. There are many factors contributing to the low uptake in use of biological controls, such as: expensive production methods, poor storage stability, susceptibility to environmental conditions and efficacy problems. Some of these problems can be overcome by formulation improvements. With many pressures on product performance,

formulation is acknowledged as an area to enhance and extend the activity of biopesticides.

Microbial Biopesticides

Focusing specifically on microbial pesticides, these formulations can present a range of challenges from end product stability to maintaining viability of a microorganism. Formulation knowledge and expertise is often required to help overcome these challenges and achieve end product success. This is why, at Croda, we are concentrating on formulation developments that address specific needs for microbial biopesticides. The process used to prepare the microorganism for formulation will provide important considerations on the choice of formulation type and ingredients needed to support delivery.

The first key consideration in any formulation development is to know your active ingredient. Microbes are complex and often show variability; within the same species different strains can report different performance, the same strain can report different performance when it is under external stress, depending on the target, one strain may perform better than another and the morphological structure of the microorganism is extremely important - each strain has its own peculiarities. It is essential to select the right formulation type according to the microbe. Choosing the optimum ingredients to stabilise the formulation is important and is guided by fundamental chemistry. Thermodynamics, phase balance, solution behaviour, surface and colloid science all drive informed surfactant selection. It is key to build an understanding of surfactant interactions with the microbe for compatibility assurance. The most commonly used formulations are oil based (oil dispersions (OD) / emulsifiable concentrates (EC)) or solid based (wetable powders (WP) / water dispersible granules (WDG)) to minimise water exposure, but these are not the only options.

Alongside formulation development, it is necessary to consider the method of application to be used with the product: foliar application, in-furrow or seed treatment, amongst others. This will

also drive the selection of the formulation type and components. Lastly, knowledge of the target disease or pest and the mode of action of the microorganism has a driving role in the choice of formulation technology, as well as component selection. Besides providing stability, formulation delivers step changes in efficacy.

To help with formulation troubleshooting and design, it is useful to understand what can impact shelf life in the formulation. The two main factors are stability of the formulation and loss of microbial viability. To help provide stability and performance features, most formulations contain a surfactant system. To deliver the optimum performance, generally the surfactant system is a blend of several components. The total surfactant concentration is usually fixed and the ratio of each component must be carefully balanced. To help determine these ratios Croda has developed the Experimental Design Tool which enables you to change the surfactant ratios methodically so that an optimum composition can be identified. A more detailed explanation of this can be found on Croda's Crop Care website (www.crodacropcare.com). An OD formulation is one of the best options to maintain the viability for a longer period, by avoiding the presence of free water in the formulation. Croda has extensive knowledge in OD formulations and can help you with new developments.

Besides shelf life stability, microbial formulations must be suitable for dilution in water in the spray tank. Formulation development needs to ensure the use of stabilisers for the dilution phase. Knowledge of the dilution conditions, how the formulation behaves in water or oil and how it interacts with the other materials present in the tank mix is key for the selection of formulation ingredients that will provide the optimum performance.

To successfully develop microbial formulations that do not experience loss of viability, superior formulation additives are essential. Croda's innovative products simplify formulation development by providing excellent and reliable performance. This is demonstrated in Figure 1, showcasing results from a viability study with *Trichoderma sp.* Specialised surfactants, a modified styrene acrylic polymer (Atlox Metaspense™ 550S) and/or a polyoxyethylene sorbitol hexaoleate (Atlas™ G-1086) are shown to have no detrimental impact on microbial viability and can be successfully utilised in stabilisation mechanisms during formulation development.

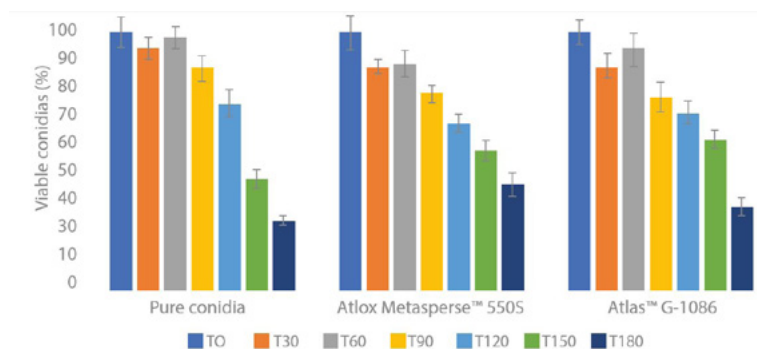


Figure 1. Viability test results of *Trichoderma sp.* with Atlox Metaspense 550S and Atlas G-1086 over a time period of 180 days

Croda also has the ability to produce improved grades of many of our products. Higher levels of purification reduce the impurities that can impact the viability of the microbe. Options to support developments extend to our manufacturing sites; here we are able to refine our processes to produce high purity variants of our standard materials. This reduces the level of impurities or residual water which can impact the viability of the microbe.

Numerous parameters can impact the viability of microbials, including drying methods, susceptibility to formulation aids and additives, prolonged periods of storage and environmental factors. All of these can ultimately limit the efficacy in the field. Methods for assessing viability, such as colony counting, are an important part of ensuring a successful formulation development. Choosing appropriate technologies for maintaining viability and evaluation allows for a more efficient formulation development process.

When considering in house developments of microbial formulations, available facilities and equipment for continuous testing are vital to success. This can often mean outsourcing of certain aspects of the development work, however, at Croda we have access to all of the necessary equipment and expertise to support your developments. Amongst others, some of the critical testing parameters essential to success include high definition microscope imagery, in-vivo microbial testing, biological viability testing, recovery screening and seed treatment application feasibility. Necessary testing also extends to formulation stability testing more commonly seen in standard synthetic based crop protection products: particle size distribution analysis, emulsion performance and rheometry being some of the most regularly utilised.

As has been detailed in this article, microbial pesticides have great potential to deliver performance advantages but can present a range of challenges from end product stability to maintaining viability of a microorganism. Therefore, formulation design is essential to the success and acceptance of these products. In general, the formulation should: increase shelf life, facilitate handling and application, enhance bioactivity, protect against external factors and maintain a good distribution of the microorganism. At Croda we recognise that biologicals have an important role to play in sustainably improving agricultural yields and contributing to global food security. That is why we actively encourage collaborations for developments in this area.

Incotec: Microplastic-Free Solutions Are Here to Stay



Dr. Marta Dobrowolska

Research & Technology Manager for Incotec

Are microplastic-free solutions just another trend in the seed treatment industry? Can we match the performance of conventional microplastic-containing seed treatments? Or will the new formulations need to compromise on some of the aspects of product quality?

Microplastics in the seed industry became a hot topic two years ago. In 2018 the European Chemical Agency (ECHA) published their first draft restriction proposal in which seed treatment featured as one of the industries that contributes to intentionally added microplastics in mixtures used by consumers or professionals. By now most people in the industry are aware of the restriction proposal and the potential consequences it may bring to the seed industry. Even though lots of seed treatment producers started development work to find good alternatives, some of them have been proven to not work as well as existing solutions, jeopardising quality and therefore safety of the treated seeds for farmers, the environment and factory workers.

The amount of plant protection products applied on seeds has become more and more challenging, bringing seed treatment solutions to the edge of their performance capacity.

In the past decade, seed treatment evolved tremendously from simple formulation consisting of colour and simple binder to more advanced formulations which focus on handling safety and retention of materials on seed. The amount of plant protection products applied to seeds has become more and more challenging, bringing seed treatment solutions to the edge of their performance capacity. Formulation chemists and polymer specialists have been tasked with designing film coating liquids

(glue which binds rich seed treatments) much more robust and at the same time gentle for the germinated seed. This to ensure that the growing plant gets the best start to life. Some of the improvements brought by seed treatment include better dust-off, flowability, abrasion resistance, cosmetics, growth, yield, shelf-life and germination. Not forgetting the decrease in the amount of the plant protection product that needs to be applied compared to the traditional spray application. None of it would be possible without careful selection of the right polymer from a broad range of available polymers chemistries.

So, the questions really are: Can the new microplastic-free formulation address those challenges as well as its predecessors? Can we expect that a microplastic-free formulation that eventually degrades in the environment will still be robust enough to protect the seed, the farmer, the environment and the factory workers?

Microplastic definition

Firstly, let's start with the definition of microplastics according to ECHA. At the moment, a microplastic is defined as a polymer-containing solid or semi-solid particle having size of 5 mm or less in at least one external dimension. The initial working definition did not distinguish between synthetic, naturally occurring or modified naturally occurring polymers. Neither between water soluble nor water insoluble polymers. Nevertheless, these elements have been recognised as important for the risk assessment and information on these aspects have been added to the final restriction proposal.

Following this, the current definition of microplastics was

based on the term 'polymer' and many may argue that not all polymers are plastics but all plastics, and therefore also microplastics, are polymers. One reason for doing so was that the term 'polymer' is defined under Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) whilst plastics are not. ECHA recognises that polymers that occur in nature in solid or semi-solid particulate form, like cellulose or starch, can be inherently biodegradable and therefore should not be considered microplastics. Nonetheless, additional data on the release to the environment and biodegradability might be required for the exemption. Next to that, polymers that are water soluble will also remain soluble after release into environment, therefore they will be unlikely contributors to microplastic concern. Still, there is a need for the appropriate threshold value for demonstrating solubility, which is under discussion now and will most likely be added to the final restriction.

Finding the best solution will be demanding but not impossible.

State of the art

Microplastic will be present in the environment for a long time after their initial release and following this, they will accumulate and cause potential health risk. They are resistant to normal environmental degradation, which is the biggest concern moving forward and the basis for the restriction. Alternatives that will ensure this will not happen need to be sought after. As mentioned previously, current solutions in seed treatment may contain solid non-degradable polymers like polystyrene or polyacrylate copolymers which are water dispersible but not soluble. They have been designed as film-formers that ensure good adhesion of all components onto the seeds which also need to allow the optimal movement of water in the seed coating and must be non-hazardous for the seed as well as for the growing plant. This delicate balance needs to be translated onto the new solutions and as they need to be much more biodegradable or soluble than current ones we must ensure that this will not create new problems with on-shelf stability for both formulations and coated

seeds or ease of application. Finding the best solution will be demanding but not impossible.

Regulatory restraints might be the catalyst for the move but now more than ever we should make sure that we take the right decisions for the future of our planet.

Sustainable future

For all those reasons microplastic-free seed treatment presents itself with great challenges but also great opportunities for even greater sustainability. United Nations Development Programme has established sustainable development goals and by moving towards microplastic-free solutions for seed treatment we can surely contribute to the sustainable management and protection of marine and coastal ecosystems – Life below water. Microplastic-free is not only a trend, it's here to stay and we can be certain that we will see the seed industry move towards microplastic-free film coatings, pellets and encrustment technologies. Regulatory restraints might be the catalyst for the move but now more than ever we should make sure that we take the right decisions for the future of our planet.

Microplastic-free film coatings will be launched in the second half of this year.

Moving forward, Incotec has prepared series of new products for sunflower, corn and vegetable seeds that are microplastic-free. These new and innovative products address all the most important aspects of conventional seed treatment, making sure that all the features of advanced seed treatment have not been lost. Microplastic-free film coatings will be launched in the second half of this year. Incotec will make sure that its full portfolio is microplastic-free and sustainable to the max, which is the direction of Mission Zero.





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4. Liquid fertilizer synergist
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2. The process of using surfactant

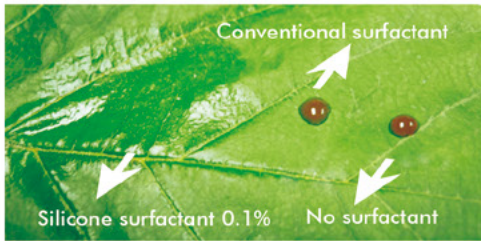
100% Organosilicone

100% Polyether modified trisiloxane surfactant

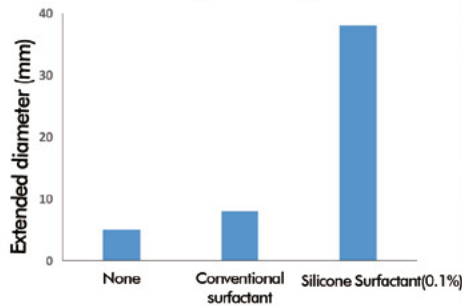


Dreamlike effect of silicone

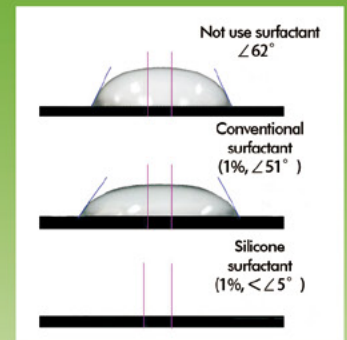
Super spreader



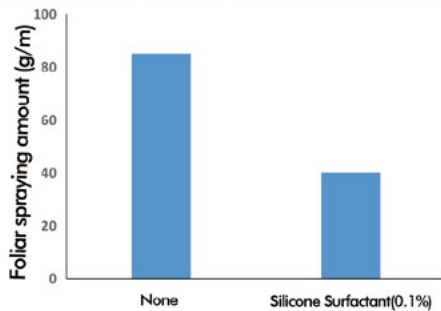
Increase spreading area



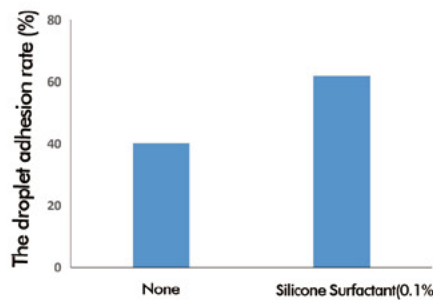
Lower contact angle in maximum



Silicone affects the droplets spraying volume & adhesion on the cucumber



Spraying volume: Reduce pesticide dosage 52.9%



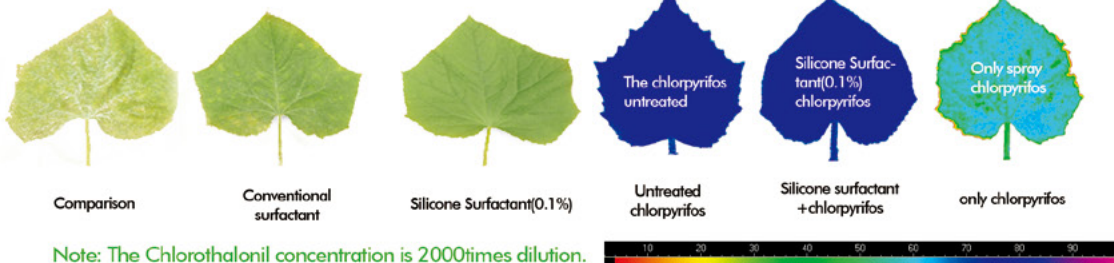
Droplets adhesion rate: Increase pesticide adhesion rate 62.5%

FEATURES:

- ◆ Superwetter
- ◆ Enlarge spray coverage
- ◆ Rapid uptake
- ◆ Rainfastness
- ◆ Compatible with most pesticides

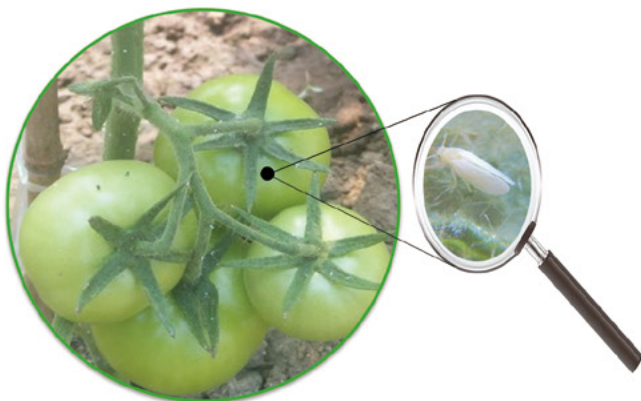
The scab number on leaves per plant

Reduce the phytotoxicity of the pesticides on plants, enhance photosynthesis



Note: The Chlorothalonil concentration is 2000times dilution.

For red spider, scale insect and whitefly which have wax layer on their bodies, the liquid pesticide is not easy to contact with the insect body, The permeability of silicone surfactant helps pesticide penetrates into insect bodies and improve efficiency of systemic insecticides.



Surviving whitefly



Died whitefly after medication with silicone

COMPANY DIRECTORY

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Stepan Company



Stepan Company is a major manufacturer of specialty chemicals including surfactants, antimicrobials, fabric softening quaternaries, phthalic anhydride and polyurethane polyols, as well as specialty ingredients for the food and nutraceutical markets. Stepan was founded in 1932 by Alfred C. Stepan Jr. Today, the company has 19 global manufacturing locations, more than 2,200 employees worldwide and over 1,800 product offerings.

Stepan Agricultural Solutions offers a robust pipeline of innovative products and actively seeks to be the strategic supplier of choice for your agricultural chemical needs. Our global research network and geographic footprint is such that we can effectively meet the needs of our customers around the globe.

In addition, our industry-leading, in-house formulation expertise in emulsifiable concentrates, microemulsions, suspension concentrates and dry products provides a value-added service to help solve customers' most difficult challenges.

<http://www.stepan.com/>
techserv@stepan.com

SINVOCHEM



SINVOCHEM is a chemical company specializing in agrochemical adjuvants.

With sustainable application scenario-oriented technical innovation strategy, SINVOCHEM has gained good reputation as main supplier for formulators in China. Backed by a group of passionate scientists and well-constructed formulation or spraying mimicking systems, SINVOCHEM succeeds in setting customized services as priority.

Now SINVOCHEM maintain a good cooperation with over 70% top of domestic formulators and main agro institutes. In recent years, SINVOCHEM is successfully cracking overseas market through locally formulation lab construction and in-tailored service collaborated with MNCs or leading distributors.

In a word, SINVOCHEM provides not only various adjuvants, but also application scenario-oriented solutions over formulation or spraying technology, contributing to reduced pesticide usage while elevated agrochemical efficacy.

Service & Strength:

- Built-in surfactants (Polycarboxylates, Polyols, Naphthalene Sulfonate Formaldehyde Condensate, Derivatives of polyols etc.) and tank-mix adjuvants (COCs, Silicone-polyether, Sulfosuccinate, Alkoxyates etc.)
- Support to full range of formulations with mimicking platform.
- Customized services including lab constructing/equipment or instrument selecting/ personnel or on-site production training...

www.sinvochem.com
export@sinvochem.com

Nouryon



We are a global specialty chemicals leader. Markets worldwide rely on our essential chemistry in the manufacture of everyday products such as crop protection formulations, pharmaceuticals, personal care items, paper, plastics and building materials items. Building on our nearly 400-year history, the dedication of our 10,000 employees, and our shared commitment to business growth, strong financial performance, safety, sustainability, and innovation, we have established a world-class business and built strong partnerships with our customers. We operate in over 80 countries around the world and is a leading supplier of specialty surfactants, polymers and solvents.

Our agrochemical portfolio of industry-leading brands includes Morwets® (wetting agents and dispersants), Adsee™ adjuvants, Agrilan® dispersants, Armid® solvents, Ethylan® and Ethomeen® (alcohol and amine alkoxyates). As a global company, with local presence and a robust supply chain, we can ensure support and delivery wherever you are. Every Day.

www.nouryon.com/agriculture
agro@nouryon.com

Solvay



"Founded in 1863, Solvay is a science company developing materials, chemicals and solutions for medical and consumer goods, electronics, cars, planes, construction, manufacturing,

food and agriculture. Our purpose is to bond people, ideas and elements to reinvent progress, through an ambitious sustainability plan crafted around three pillars: protecting the climate, preserving resources and improving people's life.

Along the agricultural value chain, Solvay solutions help farmers increase crop yield in a sustainable way. In crop protection, our greener, safer formulation additives enhance efficacy and on-target delivery of actives. In plant nutrition, our nitrogen inhibitors increase fertilizer availability to the plant while reducing greenhouse gas emissions and water pollution. In seed care, we innovate with plant-based biostimulants to protect crops from drought and climate stress and natural binders for on-seed applications of future actives and biocontrols.

Experts in the field for over 40 years, Solvay Agro teams create bonds to change the future of Agriculture."

www.solvay.com
benoit.abribat@solvay.com

A

Azelis



Azelis Specialty Agri/Horti offers a comprehensive range of specialty chemicals and ingredients from first-class principals for the agriculture, horticulture, amenity, and farm care market segments. Our knowledgeable team has years of experience within the industry, helping you choose the right ingredient combination for your formulation and achieve superior results. Our local teams of passionate specialists support you in reaching your targets in terms of performance, cost-effectiveness,

and environmental protection for PPPs (Plant Protection Products), crop nutrition, and seed coatings applications. Azelis' technical laboratories, located across the region, combine ingredients and ideas to create opportunities through expertise. We can assist you in developing tailor-made formulations, troubleshooting, and testing your products.

<https://www.azelis.com/en>
AgroAPAC@azelis.com

Agrovista



Agrovista UK Limited is a leading supplier of agronomy advice, seed, crop protection products and precision farming services. Working alongside the arable, fruit, vegetable, horticultural and amenity sectors, Agrovista is committed to helping customers manage their businesses more efficiently and more profitably.

Agrovista was established more than 60 years ago and actively practices values of honesty, integrity and fairness across all aspects of the business, whilst taking pride in an innovative approach to research and development. It also embraces care for the wider environment, with an understanding of the important role now played by all those who manage the land.

The business is part of leading European organisation Agrovista BV, and overseen by international parent company, Marubeni Corporation. This makes Agrovista a significant supplier of plant protection inputs and advice, with more than 20% of the UK crop protection market.

Discovery range

- Spray application aids
- Tank-mixed spray additives and

adjuvants

- Designed to enhance efficacy of plant protection products
- Targeted formulations, focused by pesticide requirement
- Improved spray application
- Supported by pan-European R&D program
- Comprehensive efficacy data to support use
- Made in Britain

www.agrovista.co.uk
peter.mcdonald@agrovista.co.uk

B

Borregaard



Borregaard operates one of the world's most advanced and sustainable biorefineries. As a world leader for Lignosulfonates and modified Humic acids, we take great pride of offering the crop protection and the fertilizer industries environmentally friendly alternatives to petroleum and coal based chemicals.

Our wide range of dispersants like Borresperse, Ufoxane and Greensperse can greatly help to produce high quality dry and water-based formulations. We offer also natural performance-enhancing ingredients for Plant Nutrient and Fertilizer Formulators like our soil conditioners BorreGRO and our micronutrients Borrechel.

www.lignotechagro.com
 • +47 69 11 80 00 for Europe/Middle-East/Africa
 • + 1 715 359 65 44 for America
 • +65 6778 0008 for Asia

BASF - Industrial Formulators



BASF's Industrial Formulators business has an excellent track record of delivering high-value solutions to a wide range of applications and a key application area is additives for crop protection formulations. As an expert partner we work in close cooperation with our customers aiming at sustainable growth through innovation. We build on our core technologies in response to market needs in all regions, including the emerging markets.

With our solutions for your formulation challenges, BASF helps to improve your adjuvants and pesticide formulations. Our broad product portfolio includes solvents, surfactants, formulated blends and dispersants.

<http://agchem-additives.basf.com/>
industrial-formulators-eu@basf.com

C

Croda

CRODA

Croda's mission is to deliver targeted innovation to sustainably improve agricultural yields and contribute to global food security. Our high performance formulation aids and novel range of adjuvants mean that you can accomplish even the most challenging formulations without an adverse impact on the environment. Our wide range of products cover many areas such as; drift reduction technology, uptake enhancement adjuvants, superior rheology modifiers, high electrolyte solutions and advanced dispersant technology.

www.crodacropcare.com
claire.hunt@croda.com

Central America Toll-Manufacture & Logistics (CTL)



Central America Toll Manufacture & Logistics (CTL), is a hub for manufacture AG products, focused in competitiveness & service. Covering Central America, Caribbean, Mexico & United States markets, manufacturing in a Foreign Trade Zone. CTL is a company dedicated mostly to manufacture under contract "CUSTOM MANUFACTURE" for crop protection products providing and efficient supply chain that integrates materials, productions and logistics, aiming to continuously improve the level of competitiveness of our customers.

www.agroctl.com
gazzari@agroctl.com

D

Dow | The Materials Science Company



Dow is a global solutions provider of inert and additive agrochemical ingredients for both adjuvants and pesticides with in-depth product performance expertise to meet specific needs of our customers by customized solutions and global supply capabilities.

- Focused on the Agrochemical market: Preservation, In-can Formulants, Tank-mix Adjuvants, Fertilizer Additives Nutrition, Agro Intermediates
- Primary product focus – Surfactants,

Amines, Solvents, Chelants

- Our newly introduced POWERBLOX™ Products serve as the building blocks for formulation success
- DOW: wide range of additional products for agricultural markets – Rheology Modifiers, Preservatives, Polyurethanes and Silicone.

<https://www.dow.com/en-us/market/mkt-agro-feed-animal-care/sub-agro-crop-solutions.html>
Lwu4@dow.com

Drexel Chemical Company



Drexel Chemical Company, founded in 1972, is a manufacturer and formulator of a broad line of agricultural chemicals. Drexel is successfully represented, and selling products, in over 80 countries. There is hardly a crop growing, anywhere in the world, that would not benefit from a Drexel product. Drexel has the potential to manufacture and distribute more than 500 different products under the Drexel triangle, resulting in one of the most comprehensive lines of agricultural chemicals available. Drexel has a full GLP lab, stringent Quality Control and full capability for proper product packaging, private labeling and shipping. Our product line contains many unique formulations, particularly with respect to our flowable materials. Growers know that they can depend on Drexel for consistent quality at an affordable price. As the best value in the market, Drexel delivers maximum yield at a minimal cost.

<http://www.drexchem.com>
lshockey@drexchem.com

DOGAL PESTICIDES AND CHEMICALS INDUSTRY TRADE S.A.



Dogal Inc. has been manufacturing and exporting plant protection products since the day it was established (1989). Dogal Inc. is one of Turkey's leading manufacturers of innovative crop protection products, that are technologically advanced and scientifically proven. Our firm has a high capacity R&D laboratory and quality systems such as ISO 9001 and ISO 14001.

Main Services

- Formulator, Manufacturer and Distributor Company
- Sales and Marketing (PPP)
- R&D (Develop improved products formulation and innovative products)

www.dogaltrm.com
info@dogaltrm.com

E

Evonik Industries AG



Evonik is one of the world leaders in specialty chemicals going far beyond chemistry to create innovative, profitable and sustainable solutions for our customers. Active in more than 100 countries around the world with generated sales of €13.1 billion and an operating profit (adjusted EBITDA) of €2.15 billion in 2019, our 32,000 employees work together for a common purpose: We want to improve life, day by day.

BREAK-THRU® - Surfactant technology from Evonik

We are committed to providing specialty additives to the agricultural industry used as spreaders, penetrants, antifoams, emulsifiers and dispersants in tank mix applications as well as in pesticide formulations. With an emphasis on innovative solutions, we offer agricultural chemicals based on both siloxane and organic surfactants under the BREAKTHRU® brand name.

www.evonik.com/break-thru
break-thru@evonik.com

Exwold Technology



Exwold have 5 manufacturing sites based in the UK and specialise in contract formulation & processing of Crop Protection products using granulation technologies. Specialising in the following:

Formulation of Herbicides & Plant Growth Regulators:

- Low Pressure Extrusion of Water Dispersible Granules (WDGs) & Soluble Granules (SGs)
- Pan Granulation
- Roll Compaction
- Impregnation and Coating of Granules
- IPPC authorisation for formulation of Herbicide acids into metal salts in-situ

Formulation of Highly Active (SU) Herbicides in a dedicated facility using extrusion. Formulation of Insecticides & Fungicides :

- Extrusion of WDGs/ SGs
- Impregnation and Coating of Granules

Support Facilities

We have ISO 9001, ISO 14001 & most recently ISO 45001 certificates. We also have Top-tier COMAH authorisation at the Brenda Road site where we handle & store incoming raw materials.

In addition, we have a fully equipped laboratory and pilot plant to assist with product scale-up.

Our expert Technical Management team have an innovative approach to finding solutions, which allows us to support new product introduction & add value to your products, making Exwold a strategic partner for our clients.

www.exwold.com
enquiries@exwold.com

Eastman Chemical Company

EASTMAN

As manufacturers of agricultural formulations are challenged by ever-increasing demands to produce more and stay compliant with mounting regulations, Eastman AgChem offers a broad portfolio of trusted agricultural intermediates, neutralizing agents, catalysts, and solvents. Relying on a global manufacturing network, our team enables customers to develop compliant, high-performance solutions. Leveraging our expertise and critical materials, we can develop customized products that exceed customers' needs and demands. The development of Eastman Zendex™ agricultural solvents is the latest example of Eastman AgChem's ability to work closely with partners and respond to changes in formulation regulations and workers' safety concerns. Collaborating with Eastman experts, formulators can develop specific solutions that distinguish themselves in the market and in the field.

Eastman creates business value through environmental stewardship, social responsibility, and economic growth—now and for future generations. We view sustainability as a continuous exploration of possibilities to help bring new products to market that improve lives, our communities, and our environment.

www.eastman.com/agchem
awilliams1@eastman.com

Ingevity



Ingevity provides specialty chemicals, high-performance carbon materials and engineered polymers that purify, protect and enhance the world around us. As the world's largest producer of kraft lignosulfonates, Ingevity is committed to quality, consistency and control in the manufacturing of dispersants and surfactant systems. We offer a range of bio-based specialty inerts for plant health and crop protection, and find customers' solutions by combining quality products and unsurpassed technical expertise. Ingevity's adjuvant products are sold under the brand names AltaHance® and Altastick®. Headquartered in North Charleston, South Carolina, Ingevity operates from 25 locations around the world and employs approximately 1,850 people.

www.Ingevity.com
chemicals@ingevity.com

high quality components that ensure active ingredients can be formulated in stable products that will spread on, stick to, wet, penetrate and protect in the most efficacious way.

Our established brands include NANSA®, DEHSOCOFIX®, EMPILAN®, EMPIPHOS®, EMPIGEN® and the ENVIOMET® range.

Innospec is committed to continuously improve the sustainability of our products and help our customers respond to environmental challenges through innovation and improved product performance.

www.innospecinc.com
agrochemicals@innospecinc.com



Interagro (UK) Ltd



Interagro was formed in 1994 and has since then been at the forefront of the development of surfactant chemistry as in-tank adjuvants. It continues to be the pioneering organisation it set out to be, developing and marketing a wide range of innovative products to optimise the performance of agricultural and horticultural inputs.

Today, Interagro boasts over 100 products in 30 international markets, making it one of the leading lights in the specialist spray adjuvant business throughout the EU, Eastern Europe and North Africa.

Innospec



Innospec is a global supplier of specialty chemicals to the agrochemical market. Our adjuvants, emulsifiers, specialty solvents, wetting and chelating agents are used widely in agrochemical formulations. We develop the technology that optimizes formulations for crop protection, plant nutrition, soil improvers, tank mix adjuvants, wood preservatives, and animal health. These are time tested,

Interagro's continued investment in R&D and technology partnerships has led to many significant milestones in product introduction and market development. With a rapidly expanding world population where cost-efficient food production on ever less available land has become top of the global agenda, its future remains bright.

Dedicated to improving overall spray performance and efficiency whilst maintaining a strong and positive environmental focus, Interagro products will remain at the forefront of new adjuvant technology.

One of Interagro's great strengths is its understanding of customer and market needs and its strong relationships with third parties. It has a proven track record of obtaining products and developing them for specialist markets.

With alliances and partnerships stretching throughout the EU, Eastern Europe and North Africa, Interagro is recognised as providing technological solutions and management tools to meet the different challenges of growers in many different markets and climatic conditions.

Interagro work closely with a number of distributors to be able to offer farmers and growers even more cost-effective performance of crop protection products.

<http://www.interagro.co.uk/>
info@interagro.co.uk

IMCD GROUP BV



IMCD is a market leader in the sales, marketing and distribution of speciality chemicals and food ingredients. Headquartered in Rotterdam, The Netherlands, IMCD employs nearly 3,000 professionals in more than 50 countries. Its result-driven professionals provide market-focused solutions to suppliers and customers across EMEA, Asia-Pacific and Americas, offering a range of comprehensive product portfolios, including innovative formulations that embrace industry trends.

IMCD focuses on partnering with leading industry suppliers that offer unique and innovative products into the agrochemical market. IMCD's vast portfolio contains a complete range of inerts to achieve optimised formulations, such as: environmentally friendly, sustainable solvents; adjuvants optimising the application target; co-formulants reducing volatility and sensitivity of new active substances. In addition, IMCD offers naturally derived products that overcome typical challenges of bio-formulations and ingredients utilised for microbiological fermentation processes.

www.imcdgroup.com
Michal.archman@imcd.pl

iFormulate



iFormulate Ltd provides customised R&D and innovation services to companies working in Formulation Science and Technology. We offer consultancy, problem solving, R&D support, idea generation and development, assistance with commercialisation, and training. Our clients come from the agrochemical and biopesticides industries as well as all other formulating industries (e.g. pharma, biocides, coatings, inks, food, cosmetics, household, specialty chemicals).

www.iformulate.biz
info@iformulate.biz

J

Johnson Matthey



As the world's population continues to grow, producers are looking for more efficient and sustainable food production techniques to increase yields and meet demands.

With the demand for safer, more environmentally-friendly products, our technologies can help you innovate and optimise the properties of agrochemical intermediates

How Johnson Matthey can work with you

- Provide market-leading catalysts for development and manufacture
- Optimise unit operations for catalytic steps or particle isolations
- Build meaningful solid-state strategies to enhance IP, bioavailability and performance
- Development services for toxicology or clinical batches

- Applying our expertise in multi-component crystallisation, including salt formation and cocrystallisation
- Overcoming scale up challenges to enhance commercial manufacture, including controlled and highly potent active ingredients

Our knowledge of speciality chemicals, solid form science and catalysis means we can help create innovation in agrochemical and agriscience organisations by improving the efficiency and speed of formulation requirements providing a clear competitive advantage.

www.matthey.com
agro@matthey.com

L

Lubrizol Life Science



Founded in 1928, Lubrizol is a global specialty ingredients company serving customers in more than 100 countries around the globe. In partnership with our customers, we innovate products delivering efficiency, reliability or wellness to their end users. Lubrizol Life Science Home division is bringing this expertise to the Agrochemical market. Our products include many EPA inert listed ingredients under our brands: Carbopol[®], Novethix[™], Pemulen[™] and Glucamate[™] rheology modifiers to thicken, emulsify and/or suspend actives; Noverite[™] polymers as water softeners and chelators, dispersants and anti-redeposition agents; Chembetaine[™], Chemoxide[™] and Chemphos[™] surfactants to emulsify, wet, disperse or act as solvents.

<http://www.lubrizol.com/home/agrochemical/>
agrochemical@lubrizol.com

M

MICROMIX PLANT HEALTH LTD (MPH)



Micromix, now part of the global Olmix Group, is an R&D company focussed on adjuvants, biostimulants, crop nutrition and unique seaweed technology in all crop systems. Olmix is world leader in algae technology specialised in natural algae-based solutions for nutrition, health, hygiene of plants, animals and humans. We are dedicated to more efficient and environmental products to achieve natural and sustainable methods of food production. Micromix world class range of adjuvants combined with pesticides and foliar nutrients will enhance uptake and efficiency. UK based at our ISO 9001:2015 site we welcome contact from potential distributors around the world.

www.micromix.com
info@micromix.com

Momentive



With a 35-year heritage of innovation and expertise in agriculture adjuvants, Momentive continues to help growers worldwide achieve outstanding performance from their agrochemical treatments. Whether for tank-mix or in-can formulations, Momentive's agriculture solutions have a reputation for high-quality, powerful performance.

Silwet super spreaders and super penetrants enable agrochemical spray treatments to spread up to 10x more than conventional adjuvants to help growers

improve yield and spray efficiency—even against the hardest to wet plants and the toughest weeds. Silwet adjuvants can enable stomatal infiltration in as little as 2 minutes – providing rainfastness and spray flexibility. Silwet adjuvants provide growers confidence that each spray treatment will deliver maximum performance.

One tank treatment with a SAG antifoam provides long-lasting foam control, allowing formulators to improve productivity and providing growers more time to spray and less hassle from foam.



www.silwet.com
Marcos aurelio.belle@momentive.com

P

Polaquimia



Polaquimia[®] offers a wide range of multifunctional chemical solutions with significant competitive advantages in industrial, energy, processes and in the manufacture of raw materials.

In agrochemicals, with own brands and third party manufacturing, we are committed to improve productivity in the field.

In general, products for this sector have an objective: to achieve stability of the different formulations and the easy application of the products. Our solutions are widely used with insecticides, herbicides and fungicides, that require

among other characteristics, emulsifying, dispersing and wetting effects.

Our solutions for crop protection include a wide range of herbicides, insecticides, fungicides and adjuvants.

Polaquimia Agro solutions are always available in the precise formulation that our clients seek. We have what you are looking for!

- Emulsifiable Concentrates (EC)
- Emulsions in Water (EW)
- Concentrated Suspensions (SC)
- Wettable Powders (WP)
- Soluble Liquids (SL)

<http://polaquimia.polakgrupo.com/>
falbo@polakgrupo.com

S

SFM CHEMICALS



SFM CHEMICALS offers manufacturing know how to the agrochemical industry with focus on toll formulation, blending and packaging of a variety of standard and specialized goods for the Crop Protection Market. The formulation facility is strategically placed in the Southern part of Germany, close to European key markets. Reliable order execution and fair pricing make SFM Chemicals a recognized and appreciated service provider for German and international partners, guaranteeing a flexible planning and quick turnaround of production orders also under bonded conditions.

www.sfm-chemicals.eu
info@sfm-chemicals.eu

T

TENSIOFIX



Tensiofix is providing Surfactants (Surface Active Agents) solutions used as essential components for the formulation of agrochemical products, acting mainly for stability, dispersibility and biological efficacy.

The surfactant range consists of emulsifiers, wetting-dispersing agents and other additives.

This expertise enables to propose highperformance and cost-effective surfactants especially designed for agrochemical applications.

We also develop vegetable based biostimulants and bio-solutions for a greener agro world.

For more than 70 years, Tensiofix products have been used in agrochemical formulations all over the world.

We are committed to solving your formulation issues through a strong technical team with extensive expertise and innovation.

www.tensiofix.com
Tensiofix_sales@omnichem.be

V

Victorian Chemical Company Pty Ltd.



The Victorian Chemical Company (Vicchem) is a specialist manufacturer and global marketer of agricultural and industrial chemical products that is based in Melbourne, Australia.

Our agricultural products include spray adjuvants, wetting agents, surfactants, oil and soap based insecticides, GA based growth regulator, and bloat control products. Applications include broad-acre cropping, horticulture, cotton, forestry and pastures.

Vicchem has strong business relationships with all major Australian distributors of agricultural products and work with industry partners and customers in Asia, The Middle East, Africa, North and South America and Europe.

We provide our customers with friendly, professional service and reliable, high performance products that have been manufactured according to the quality management system ISO 9001:2015. Vicchem is also accredited to HACCP and GMP standards.

Vicchem has a well-equipped laboratory that is used in formulation development and quality control testing. Vegetable oils are used widely in our manufacture, with the resulting products being typically non-hazardous to both end user and the environment.

We invite you to visit our website or write to us at the email address below.

www.vicchem.com
products@vicchem.com



SOLUTIONS FOR GROWTH

agrochemicals formulation additives from Innospec

Multiple active ingredients, micropesticides, better efficacy and less residue: crop protection products are becoming more complex.

Innospec is a global supplier of adjuvants, emulsifiers, specialty solvents, wetting and chelating agents, widely used in agrochemical formulations.

Together with our customers, we develop new solutions that will contribute to a sustainable environment without compromising on performance.

Innospec's established brands include NANSA[®], DEHSCOFIX[®], EMPILAN[®], EMPIPHOS[®], EMPIGEN[®] and the ENVIOMET[®] range.

Contact us at agrochemicals@innospecinc.com



FORMULATION & SERVICE

Made in Germany – for your success



Customized Service – Extensive Know-how

- Agrochemical and industrial toll formulation
- Packaging and labelling
- Logistical and custom's handling (AEO certified)
- Warehousing
- Customized recipes

ATTENTION

From 2022 with increased capacity in new facilities!



SFM-Chemicals GmbH

Floßhafenstraße 11 • D-97199 Ochsenfurt • T +49 (0) 9331.802510
info@sfm-chemicals.eu • www.sfm-chemicals.eu

Member of STEFES Group