The Art of Applying Colloid Science to the Design of Formulations

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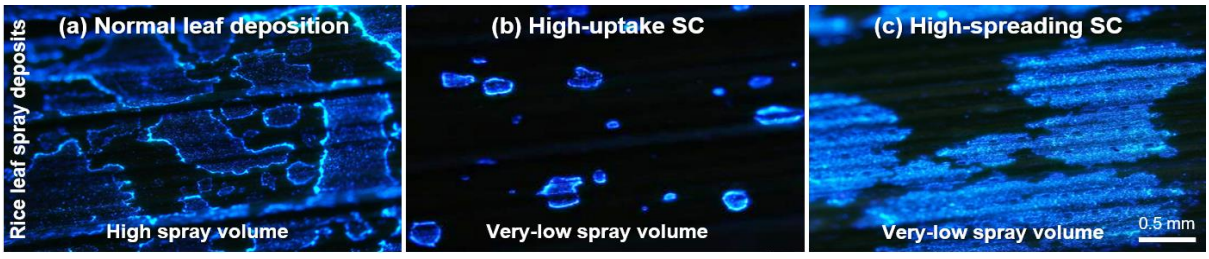
Designing formulations is a rewarding and fascinating but complex challenge, the final product must fulfil several different criteria such as performance, innovation, differentiation, safety, be registerable (globally), cost, sustainability, stability and be robust for manufacture for example. These criteria often compete against each other during formulation design and finding effective solutions in the design space is complex. How can solutions be found efficiently? The number of recipe components, process variations and product criteria make it highly unlikely that solutions will be found that could be foreseen. Some valuable insight to this challenge can be attributed to Albert Einstein; “everything should be as simple as possible, but not simpler.” This is telling us that unnecessary complexity and detail should be removed but the fundamental elements that allow the formulation design to be understood are what we should focus on. Colloid science has a very important role here to help identify and understand the fundamental elements, and then how to identify suitable recipe formulants and importantly measure their effect since “if you cannot measure it, you cannot improve it,” an abbreviated quote attributed to Lord Kelvin.

One of the most complex markets for formulation design is crop protection products for foliar spray application since they must satisfy a highly diverse range of requirements. Recently unmanned aerial systems (UAS) or drones have emerged (rapidly in APAC) as alternative and potentially disruptive methods to apply products more sustainably with the opportunity to reduce the CO_2 footprint of spray application but with the consequence of limited carrying capacity for the spray liquid (~10-30L), resulting in spray volumes down to ~8-30 L/ha (from ~100-1000 L/ha). At these very-low spray volumes, the low number of spray droplets impacts the deposition and coverage, which can result in reduced efficacy. This creates interesting opportunities for formulation design where the higher concentration of surfactants and other formulants in the spray droplets can be utilised to enhance wetting, spreading and biodelivery of active ingredients to the target.

Suspension formulations can be designed to deliver these opportunities with the challenge to optimise their physical stability. Here they form weak arrested particle gels that can collapse under gravity and rheology has an important role to understand and predict their stability and create new solutions.

This talk will cover these aspects and introduce some of the fascinating and creative colloid science underpinning the design and performance of these suspension-based formulations.



Biological efficacy	+++(+)	++(+)	++++	+	++++	+
Cuticle penetration	++	+	++++	+	++	+
Leaf coverage	++++	++++	+	+	++++	+
	with U/S	without	with uptake (U)	without	with spreading (S)	without

Foliar spray deposits on rice plants illustrating different deposit structures (coffee rings/uniform) and distributions for high (a) and low spray volumes with uptake promoting (b) and high spreading surfactants (c).