Encapsulation of Biologicals for Agriculture - Eco-Friendly Solutions for a Sustainable Future

Sustainable and Climate Resilient Food Production and Agriculture

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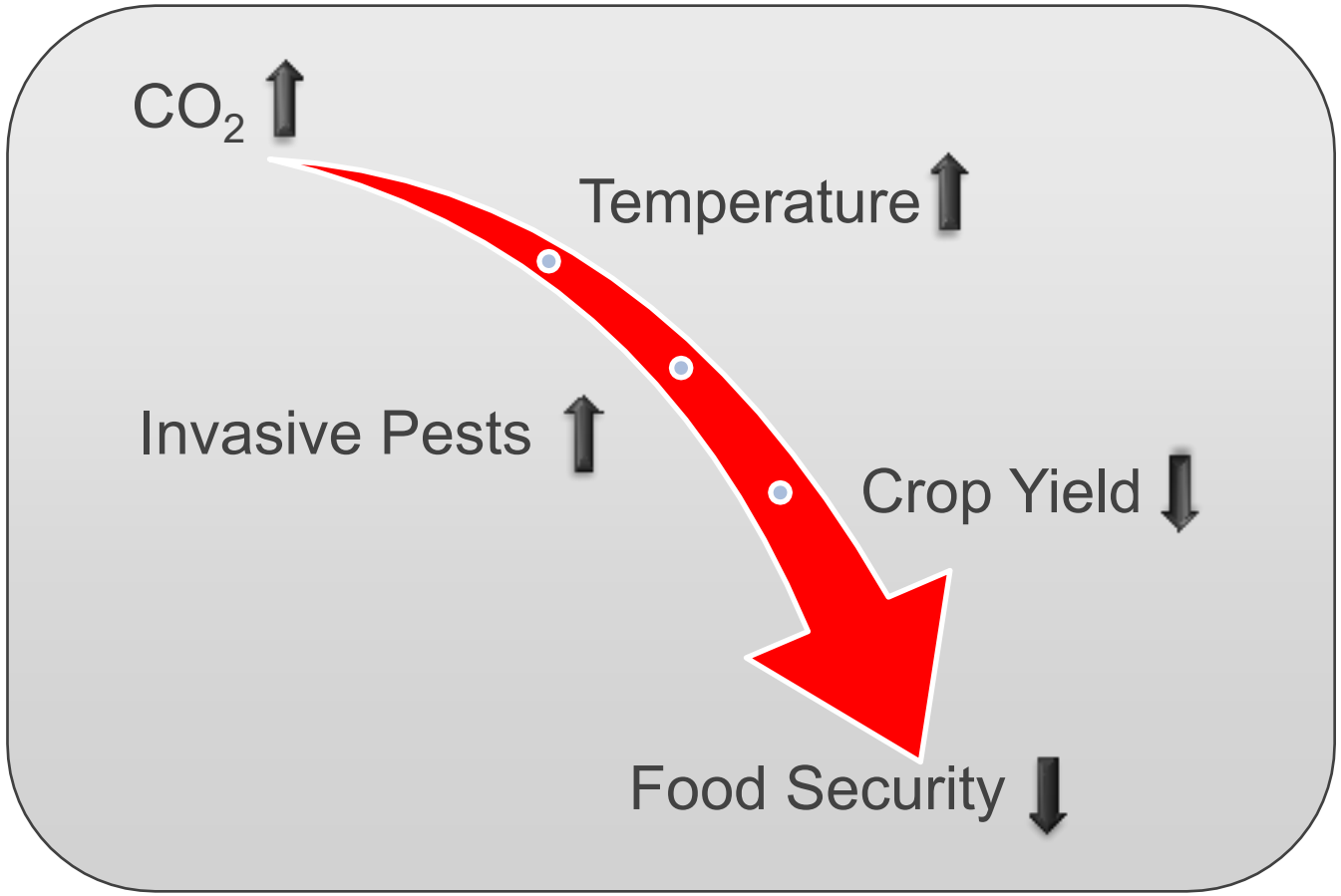
Climate Change Impacts Food Security



Credit: USDA/FAS/Curt Reynolds

The corn earworm

Credit: Anders Huseth/NC State University

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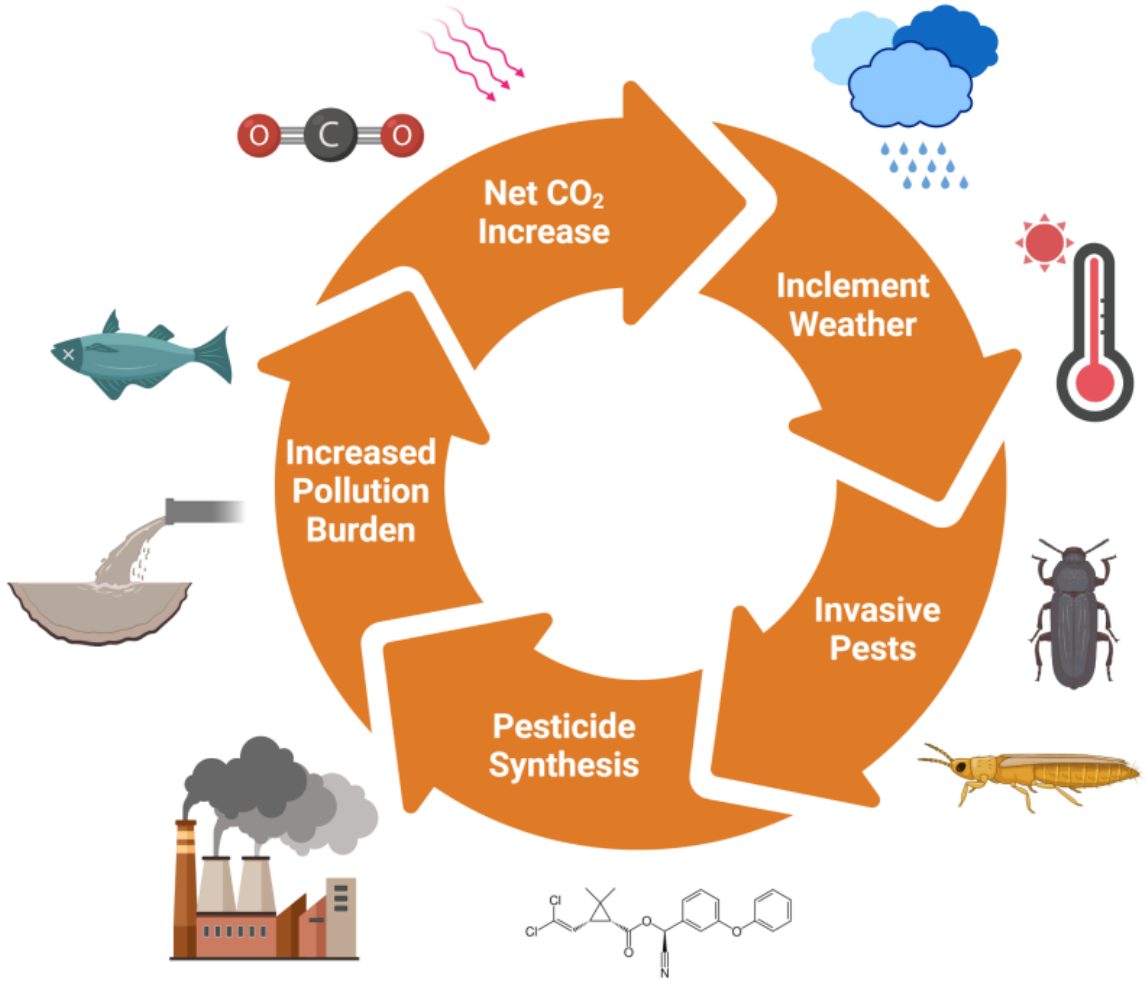
Perpetual Cycle of Climate Change in Agriculture



Created with BioRender.com

- Climate change results in rising temperatures which create stressful environments for crop fields
- Climate change alters the ecosystem, generating new niches for insects
- The extensive use of chemical pesticides to treat these new pests will increase the pollution burden as flooding intensifies
- The fossil fuels required to generate the billions of pounds of pesticide propagate the effects of climate change
- **So, what is the solution to stop this vicious cycle?**

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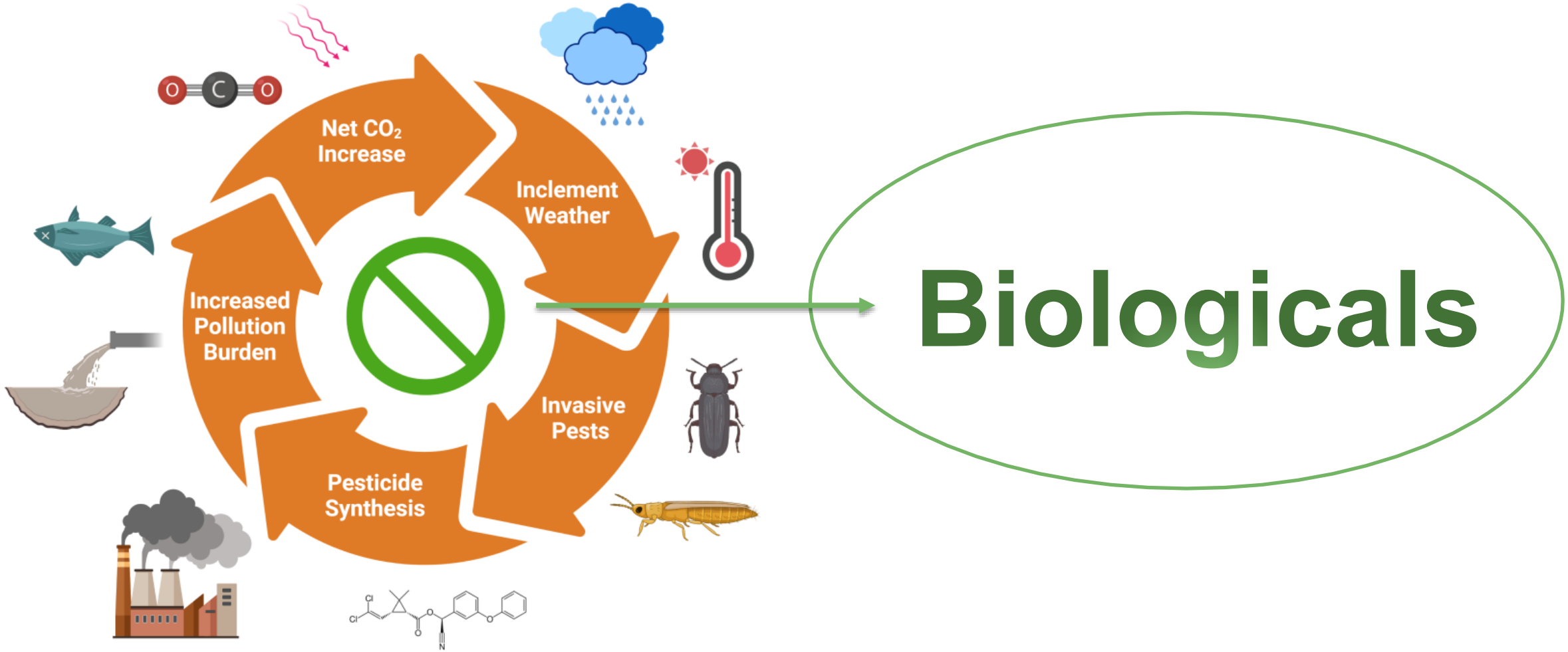
Perpetual Cycle of Climate Change in Agriculture



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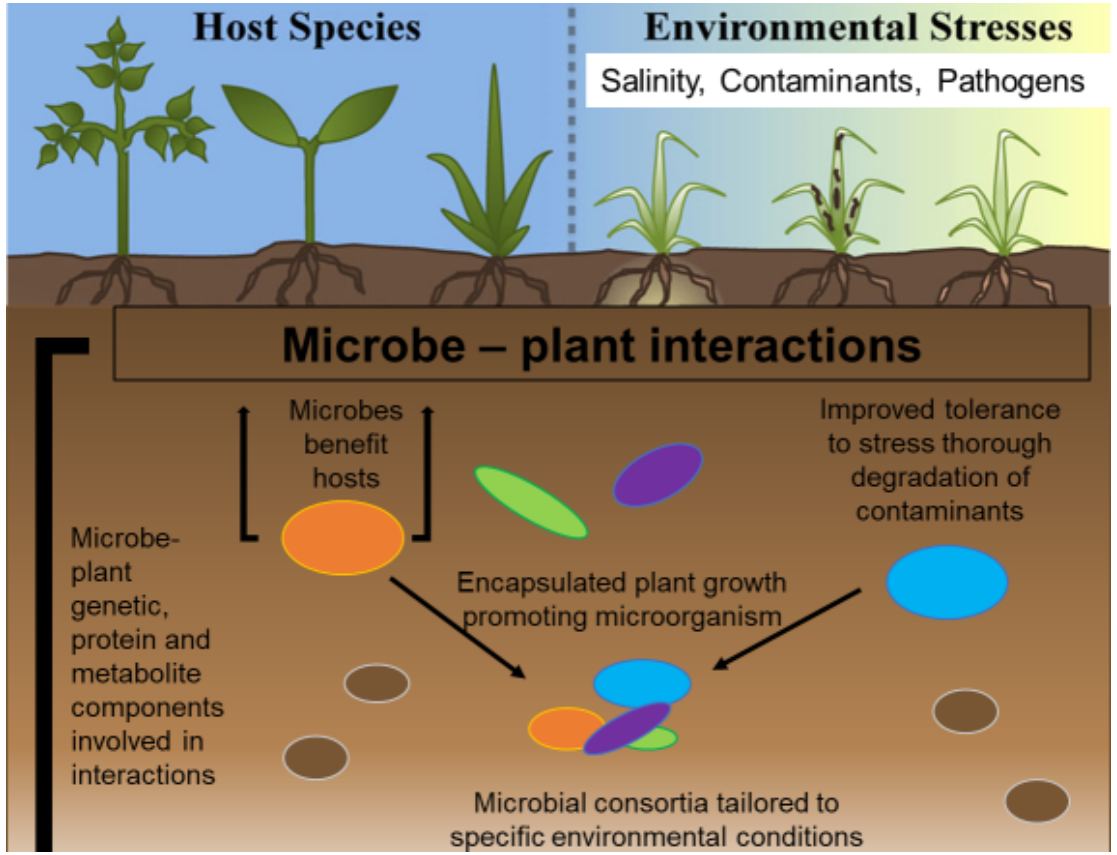
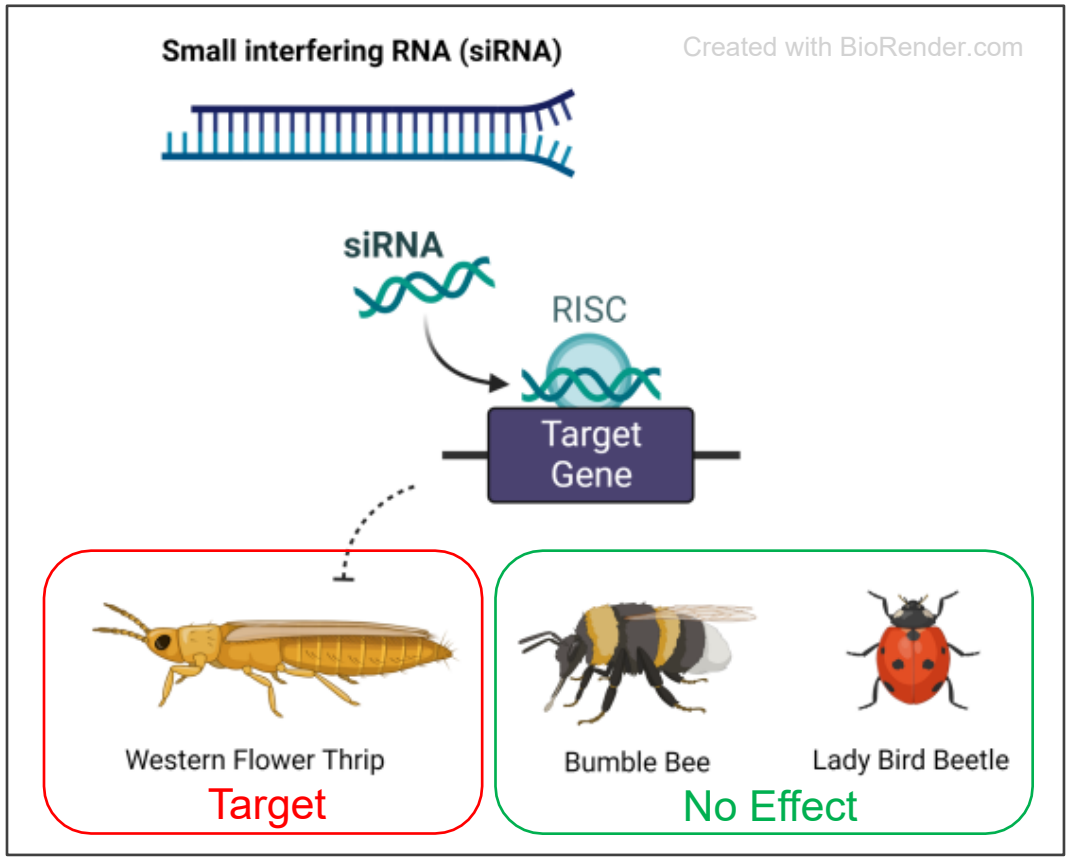
Biologicals in Agriculture

Microbes



Biomolecules



Challenge – Biologicals are significantly less stable than chemicals, so shelf-stability and field-longevity are real challenges in the development of biologicals in agriculture

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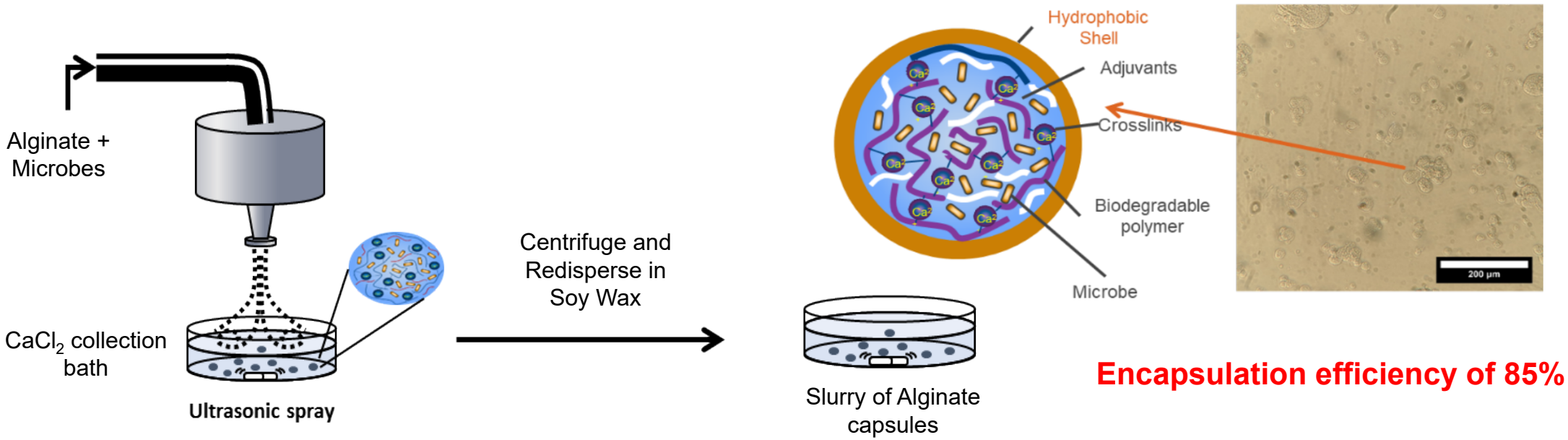
Biostimulant Encapsulation

Superhydrophobic **W**ater-Resistant **E**ncapsu**L**ation (SWEL) Technology

Generation of SWEL Capsules



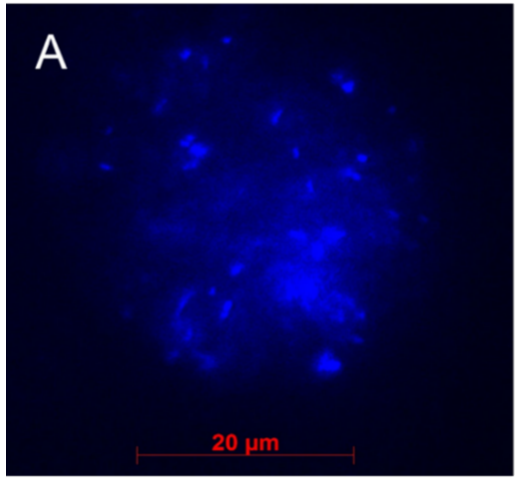
Encapsulation efficiency of 85%

SWEL technology developed and compatible with calcium alginate encapsulation process to prevent back diffusion of Chemical Seed Coating Compounds (CSCs) and decrease desiccation of microbes during the shelf storage.

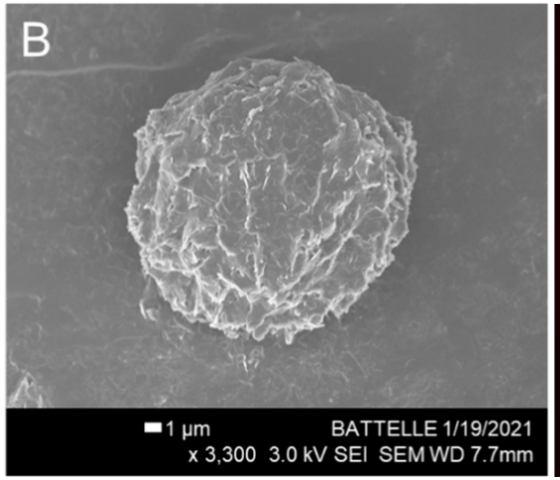
Kucharzyk *et al. ACS Agricultural Science & Technology* (2023). *Under Revision.*

SWEL Capsule Imaging

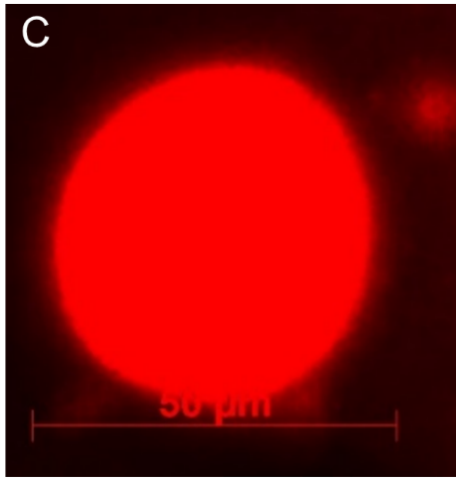
- *Pseudomonas protegens* was encapsulated in alginate and coated with soy wax to form SWEL
- Microbial cells were stained with DAPI to visualize DNA.
- Soy wax and lipids were stained with Nile Red



DAPI Stain



Electron Microscopy



Nile red

Capsules are round and show size distribution from 10-20 µm. This size is expected by agricultural formulators and aligns with expectations for product applied to the seed!

Kucharzyk *et al. ACS Agricultural Science & Technology* (2023). *Under Revision.*

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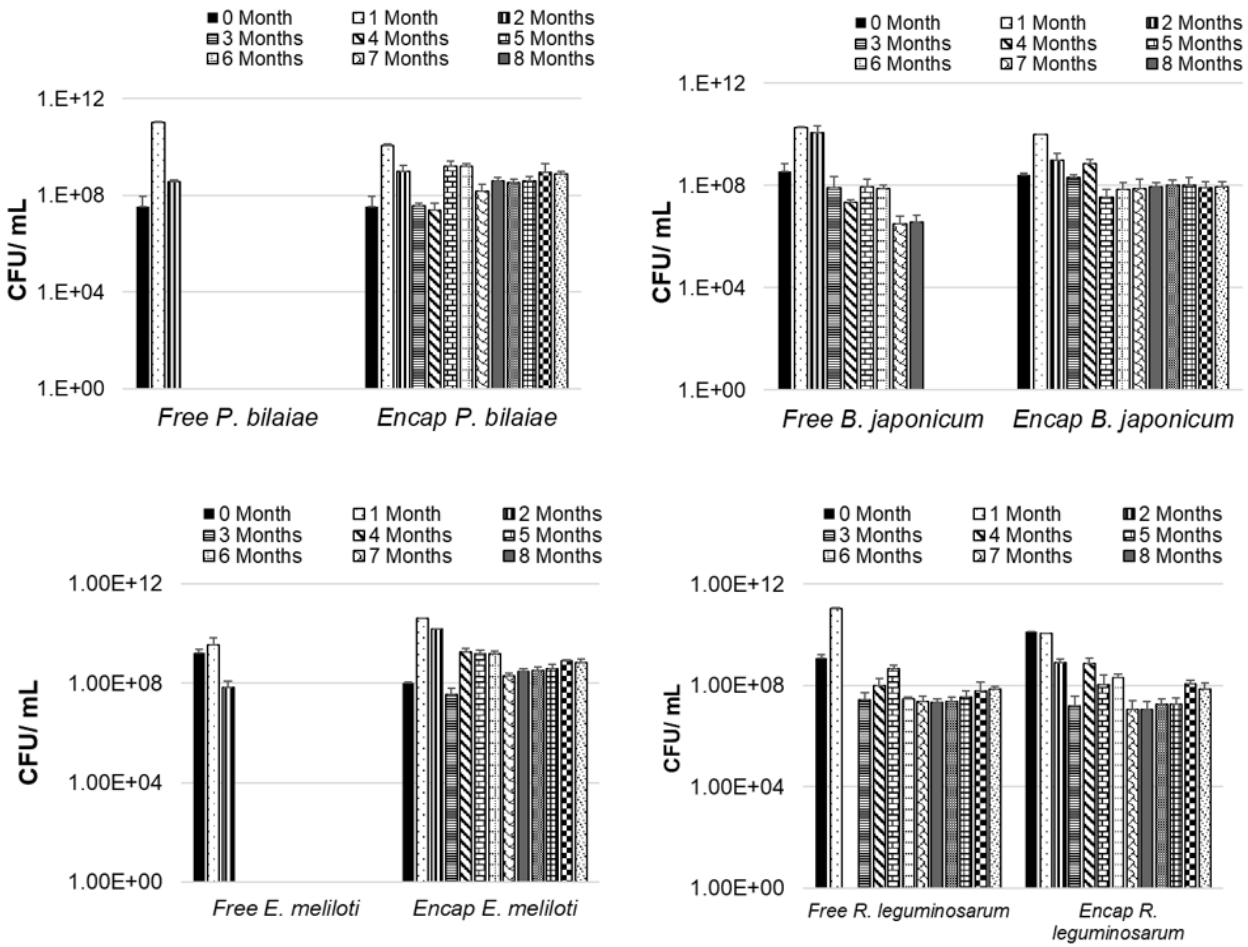
Viability Testing – Storage Stability

- Encapsulation by SWEL can significantly improve storage stability
- *P. bilaiae* and *E. meliloti* demonstrate improved storage stability
- *B. japoncium* and *R. leguminosarum* show modest improvement in stability



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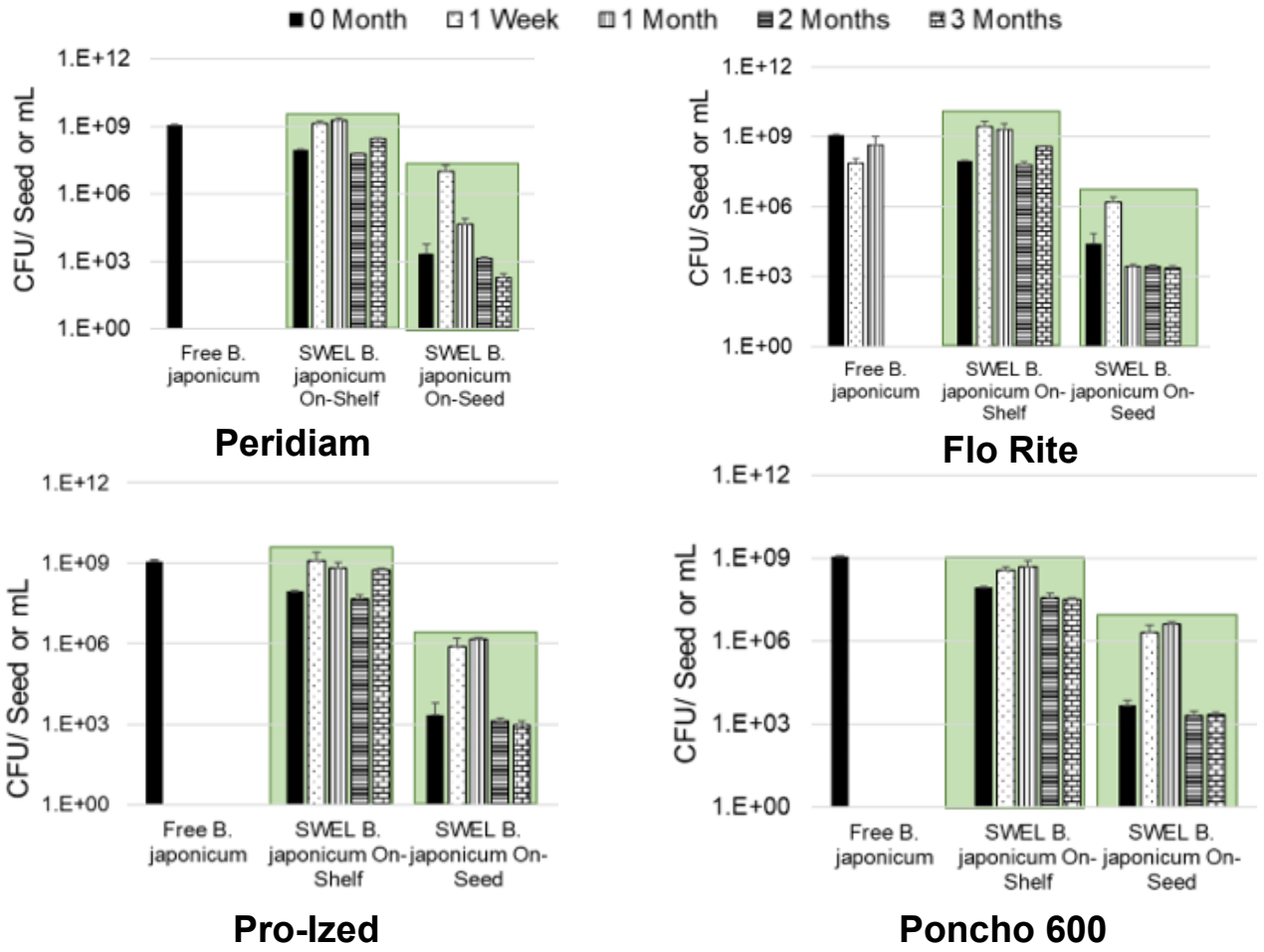
Viability Testing – CSC Compatibility

- Chemical Seed Coating Compounds (CSCs) help to:
  - Improve seed flow
  - Increase adhesion
  - Seed identification
  - Protection

Genus/ species	CSC Type	Test
B. japonicum strain (Buchanan) Jordan (ATCC, 10324)	Peridiam	On shelf and on-seed stability
	Flo Rite 1706	
	Pro-Ized Red Colorant	
	Poncho 600 FS	



See Fadime Murdoch's poster #188 for greenhouse studies

Kucharzyk *et al. ACS Agricultural Science & Technology* (2023). *Under Revision.*

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Biopesticide Encapsulation

Encapsulation of siRNA

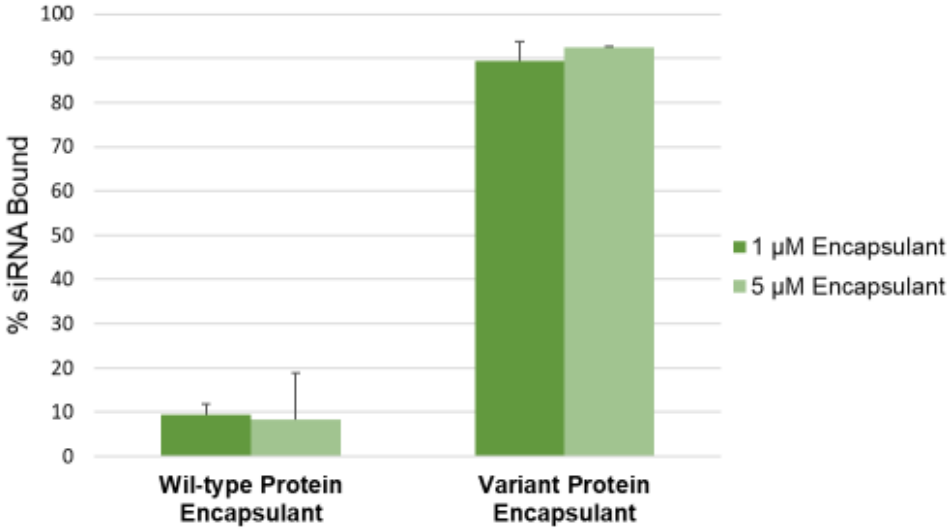
Encapsulation of siRNA in a Protein Encapsulant

- **Key Objective – Generate a sprayable siRNA-based bioinsecticide for the agriculture industry**
  - Protein framework has been engineered to encapsulate siRNA with high efficiency
  - Delivery mechanism to inset midgut was established

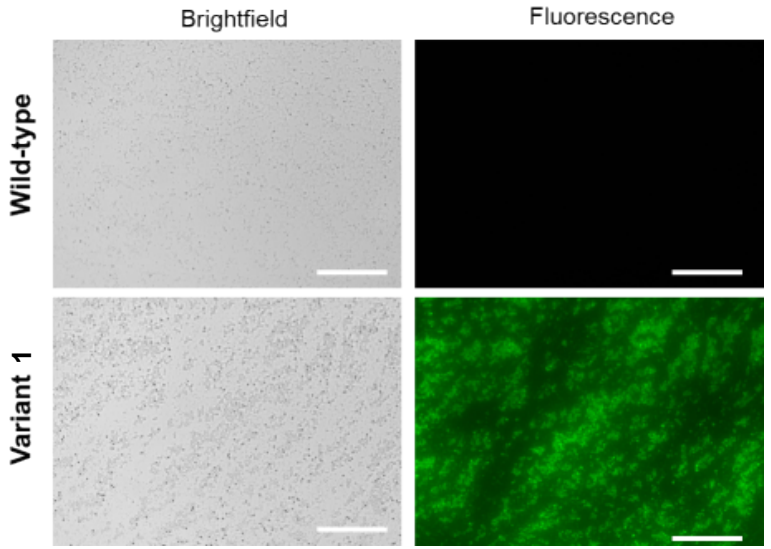
Western corn rootworm targeting siRNA labeled with fluorophore

Encapsulation

Variant 1

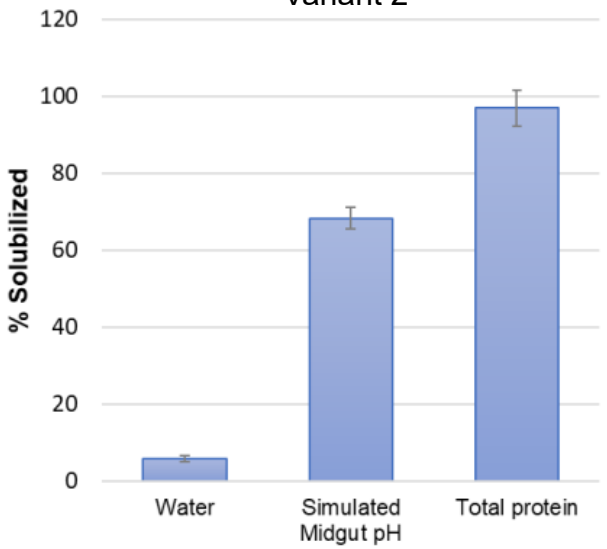


Microscopy



Release

Variant 2



Heater *et al.* Unpublished.

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Encapsulation of siRNA Team

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