Bio-based Co-formulants for Biocontrol Formulations

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ISAA 2025

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Index

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Biocontrol – a growing market

Sustainable future

Bio-based trend: during recent years major players are investing heavily in bio-based solutions.

Growth rate of 7.5% CAGR

The Biocontrol Market Industry is expected to grow from 11.78 (USD Billion) in 2025 to 22.62 (USD Billion) by 2034.[1]

Compatibility

Microorganism survival is challenged if they are not compatible with the co-formulants.

UV light degradation

Loss of activity due to UV exposure.

1. https://www.marketresearchfuture.com/reports/biocontrol-market-24867

Lignin Biopolymers and Cellulose Fibrils

LIGNIN BIOPOLYMERS

- Sulfonated lignin
- Available with different cations (Ca, Na, NH_4)
- Robust dispersant (salt tolerance, temperature, pH)
- Delivered as powder or liquid

CELLULOSE FIBRILS

- 3D network of micro-fibrillated Cellulose in water
- High available surface area with functional OH-groups
- Excellent electrolyte tolerance, temperature stability, pH (1 – 13)
- Delivered as 2% dispersion or as 10% paste

Exilva F 01-L

Exilva F 01-V

Lignin Biopolymers and Cellulose Fibrils are bio-based and non-GMO

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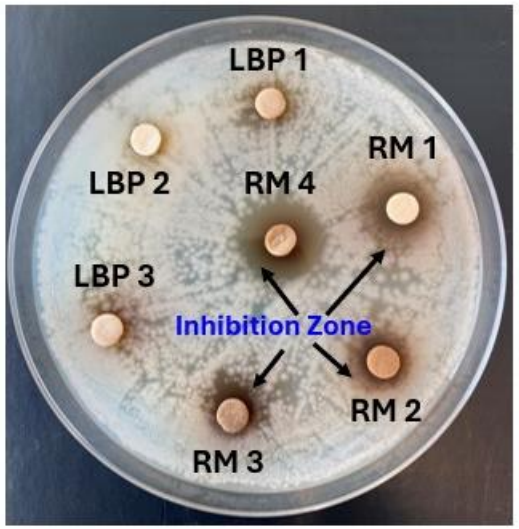
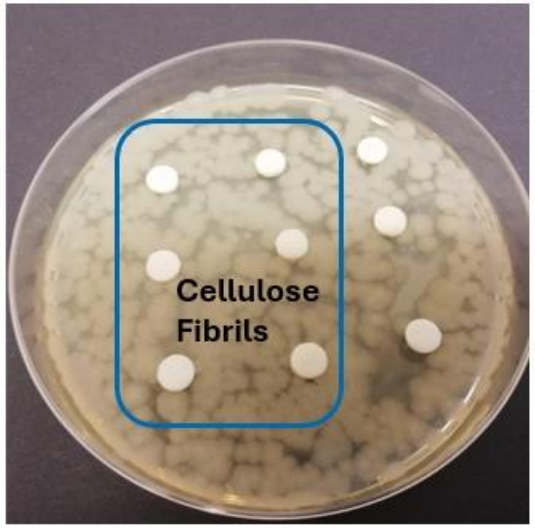
Microbial Compatibility: Lignin Biopolymers & Cellulose Fibrils

- With ***Bacillus thuringiensis* (*Bt*) –** gram positive bioinsecticide

- Disk Diffusion Assay – the Qualitative approach
  - No inhibition zone around Lignin Biopolymer (10% w/w solution) and Cellulose Fibrils (2% w/w suspension) – **Compatible**
  - Inhibition zone with reference materials (RM = commercially available co-formulants) – **Incompatible**





Lignin Biopolymer	Molecular Weight	Degree of Sulfonation
Activance UV	Low	Low
LBP1	High	Med-low
LBP2	Med-high	Medium
LBP3	Med-high	High
LBP4	High	Med-low

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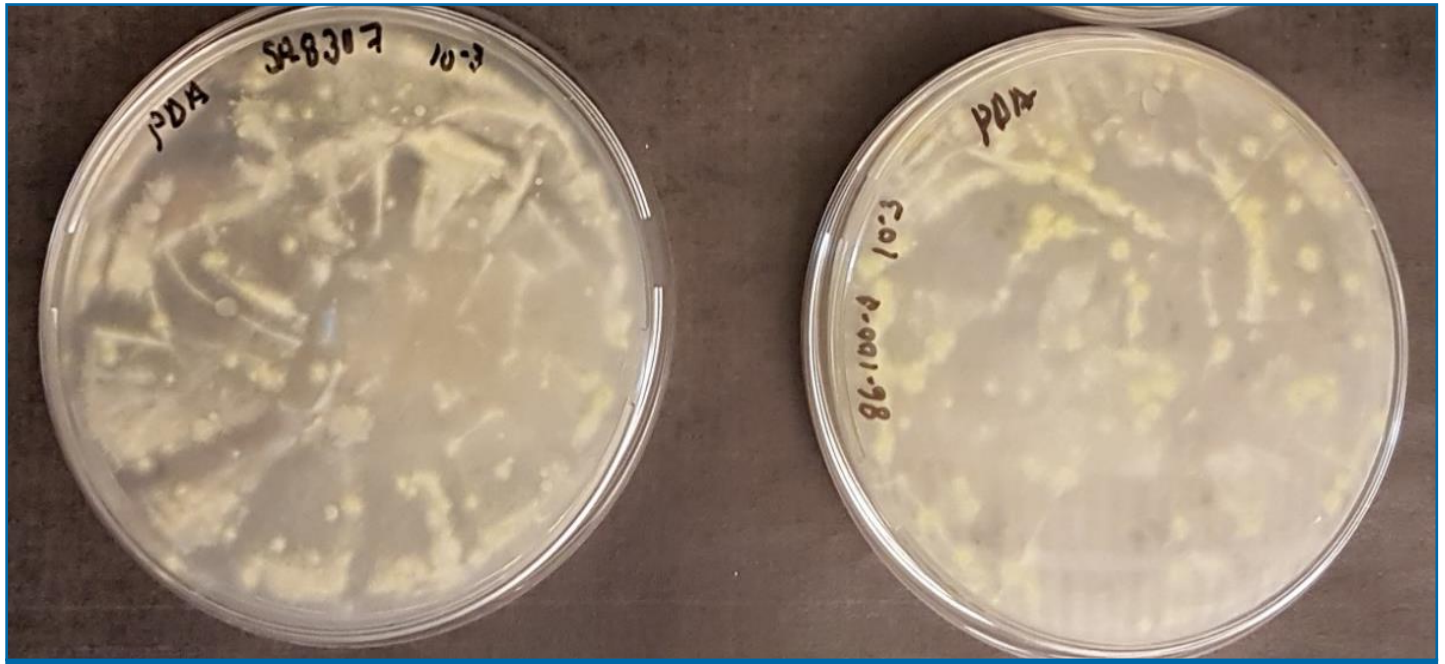
Dry Formulation - WG

- *Beauveria bassiana* WG – spray-dried (60/30°C)

  → Viability is maintained after drying



before drying | after drying

INGREDIENT	wt%
B. bassiana	70
Biopolymer	28
Wetting agent	2

DISPERSANT (LIGNOSULFONATES)	SUSPENSIBILITY (%)
Activance UV	88
LBP 4	98

Suspensibility of the granules

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Dry Formulation - Fluid Bed Granulation

- Granulated formulation
  - High suspensibility (85%)
  - Good dispersibility (15-20 inversions)

INGREDIENT	wt%
Peptide	30
Microbe	50
Activance UV	17
Maltodextrin	3

Immediately After 30 secs

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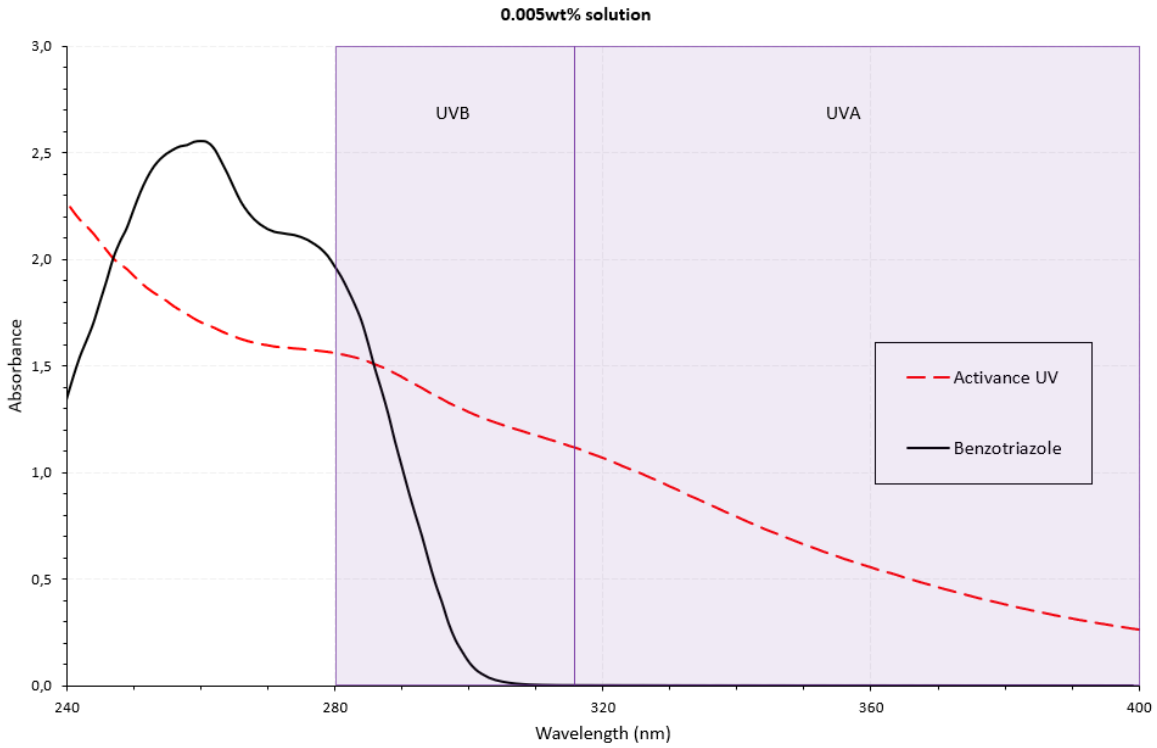
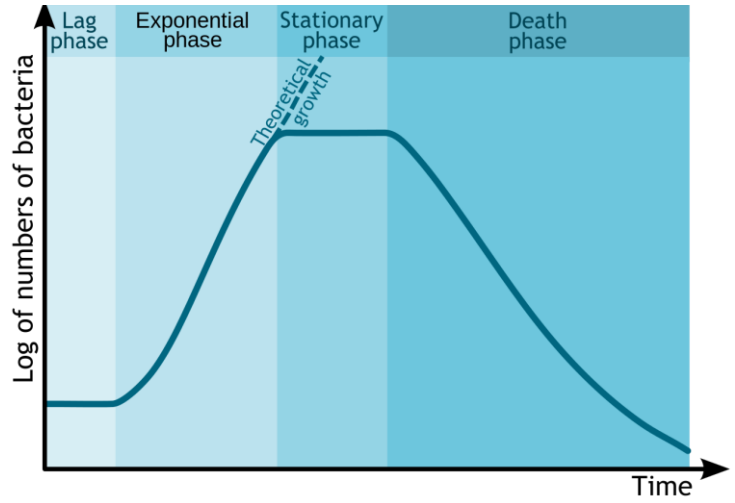
Protocol – Compatibility and UV-protection with Lignin Biopolymers

- Microbe in stationary phase mixed with **Activance® UV**
- **Quantitative**: Colony forming units (CFU) count



Radiation time = 3-4 hr, 300-400 nm, Irradiance = 40 W/m^2, temperature ≈ 45°C



Atlas Suntest XLS+

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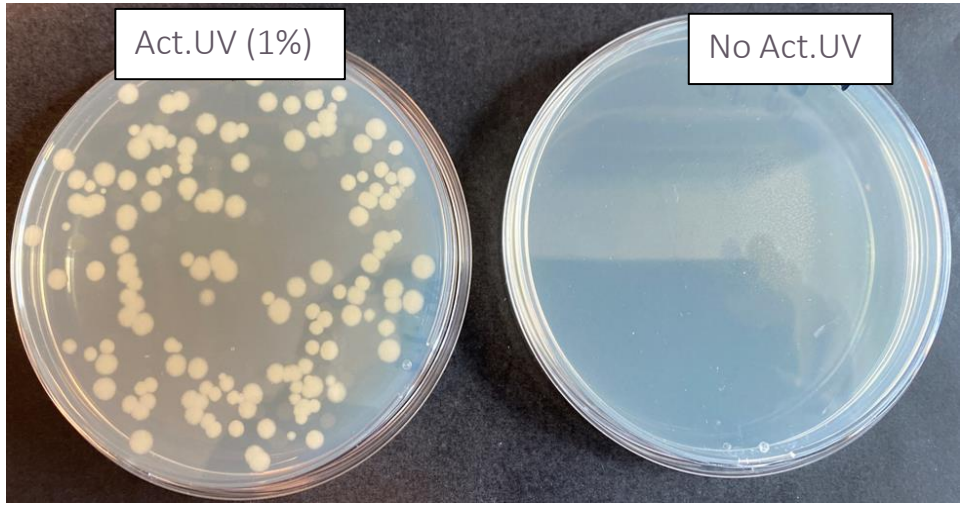
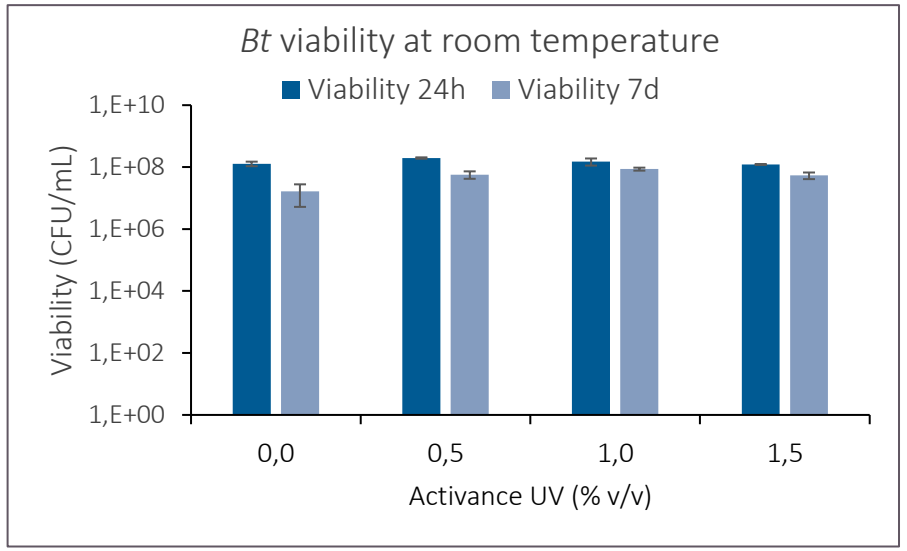
Bacillus thuringiensis (Bt) – Compatibility and UV-protection

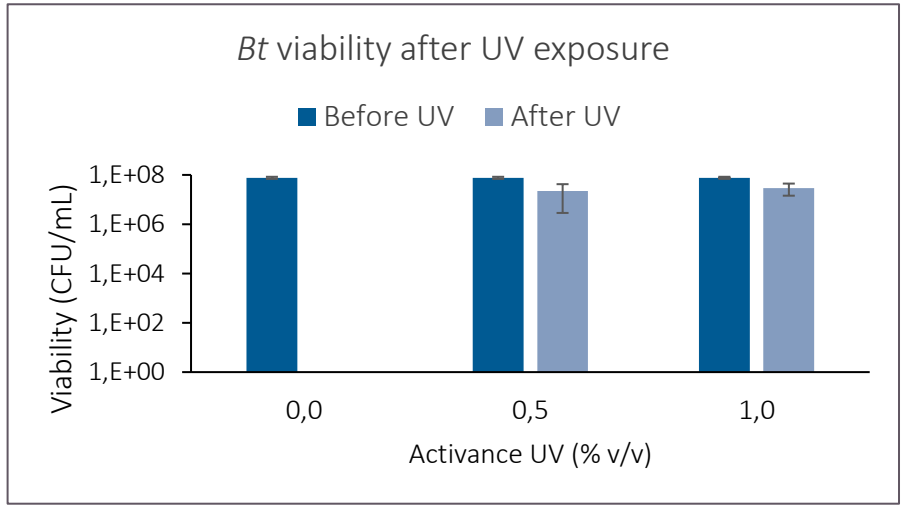
- Storage at room temperature
  - Improved viability on storage in presence of Activance® UV

- UV-protection
  - No viability in absence of Activance UV (Control)
  - Viability maintained in presence of Activance UV



Exposure time = 4 hr, 300-400 nm, irradiance = 40 W/m^2; temperature ≈ 45°C





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Bacillus thuringiensis (Bt) Formulation: Wettable powder (WP)

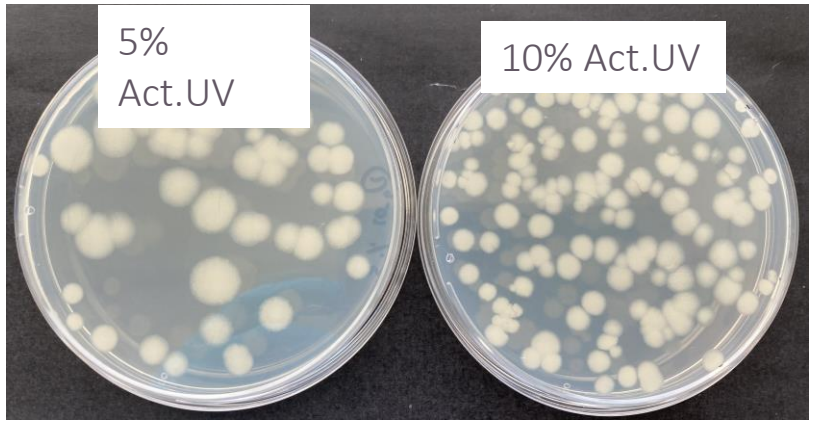
- Spray dried ***Bacillus thuringiensis (Bt)*** at low temperature (60/30°C)

- Activance® UV as an in-built adjuvant in WP
  - Suspensibility
  - UV-protection

- *Bt* suspension with Activance UV (5% and 10%)
  - Viability after 4-hour UV exposure
  - CFU = 4.5x 10^7 / mL (5% v/v Act.UV)

    = 13x 10^7 / mL (10% v/v Act.UV)

- Excellent re-suspensibility of the formulated powder



Without Activance UV

With Activance UV

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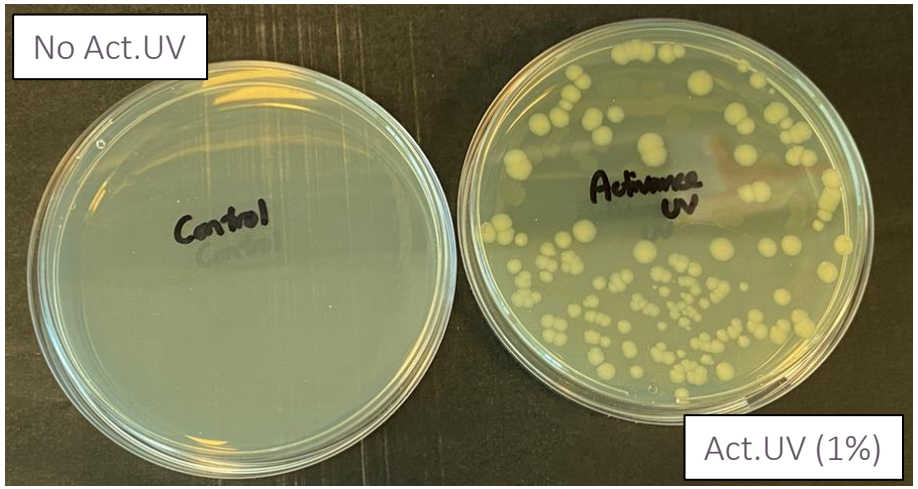
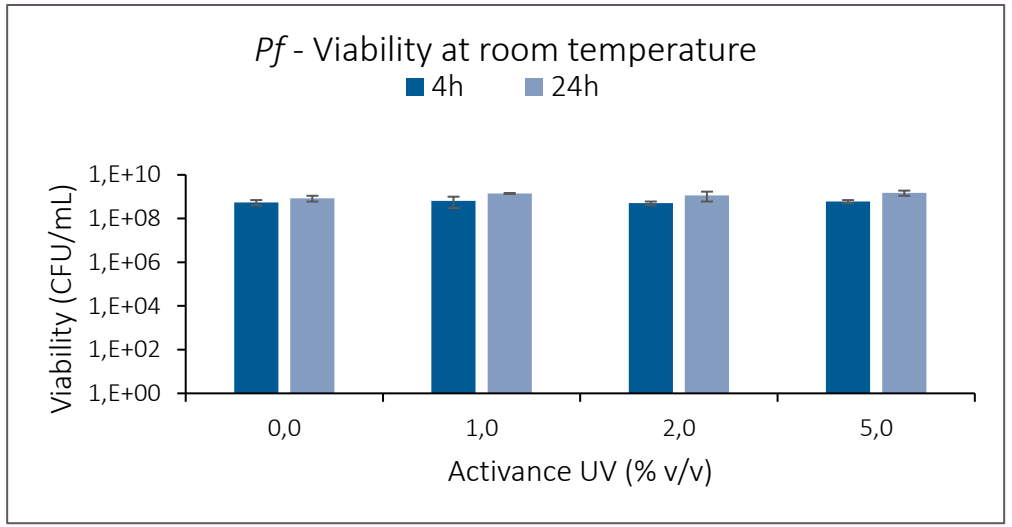
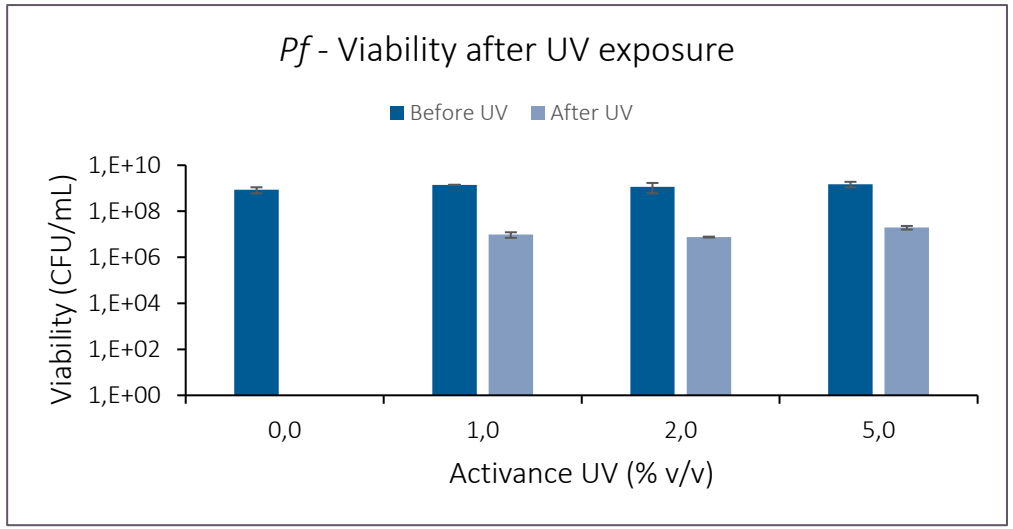
Pseudomonas fluorescens (Pf) – Compatibility & UV-protection

- Gram negative bacteria, non-spore forming, bio-fungicide
- Storage at room temperature
  - Viability maintained after 24h with Activance® UV
- UV-protection
  - No viability in Control
  - Viability observed in presence of Activance UV



Exposure time = 3 hr, 300 – 400 nm, irradiance = 40 W/m^2, temp ≈ 45°C

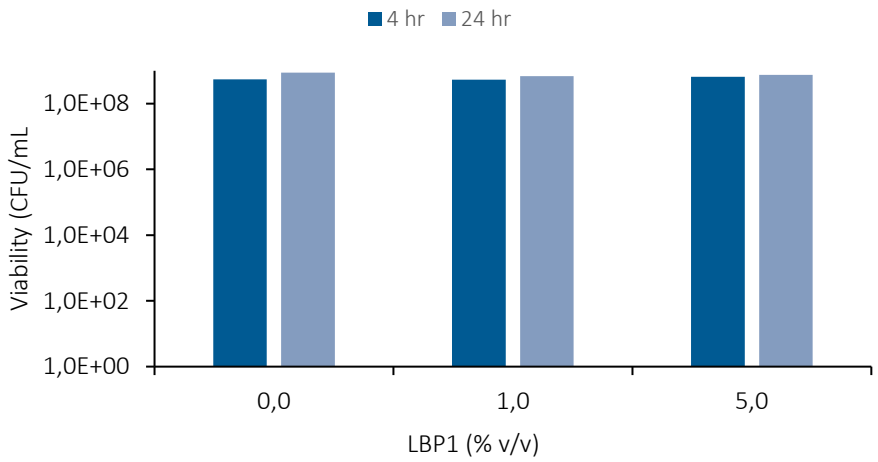




UV-protection Study with LBP1

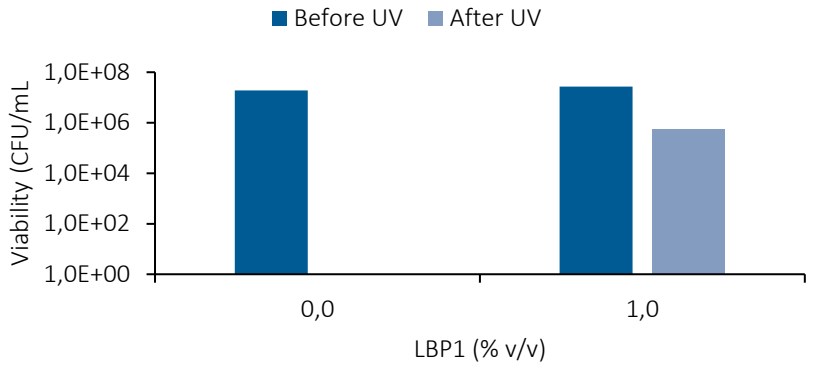
- LBP1 – high MW lignin, pH stable, med-low sulfonation
  - Popular choice for several liquid formulations
- Excellent compatibility with microbes
- Offers also UV-protection
  - Gram negative *Pseudomonas fluorescens (Pf)*
  - Gram positive *Bacillus thuringiensis (Bt)*

Pf - Viability at room temperature

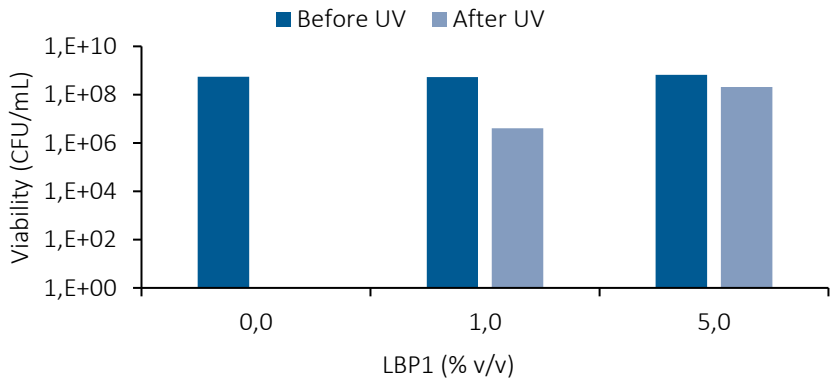


- UV test – viability in presence of LBP1

Bt - Viability after UV exposure



Pf - Viability after UV exposure



Exposure time = 3 hr, 300 – 400 nm, irradiance = 40 W/m^2, temp ≈ 45°C

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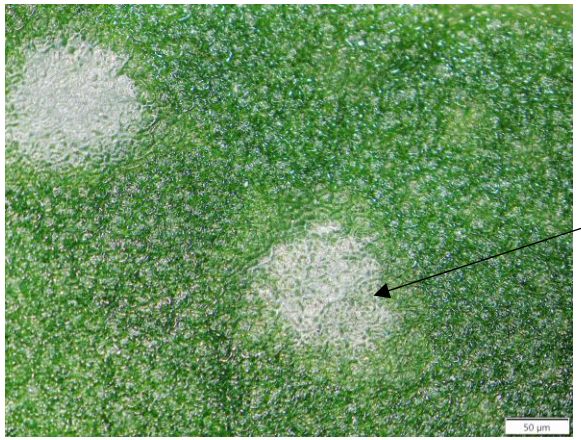
Cellulose Fibrils as Rainfastness Adjuvant

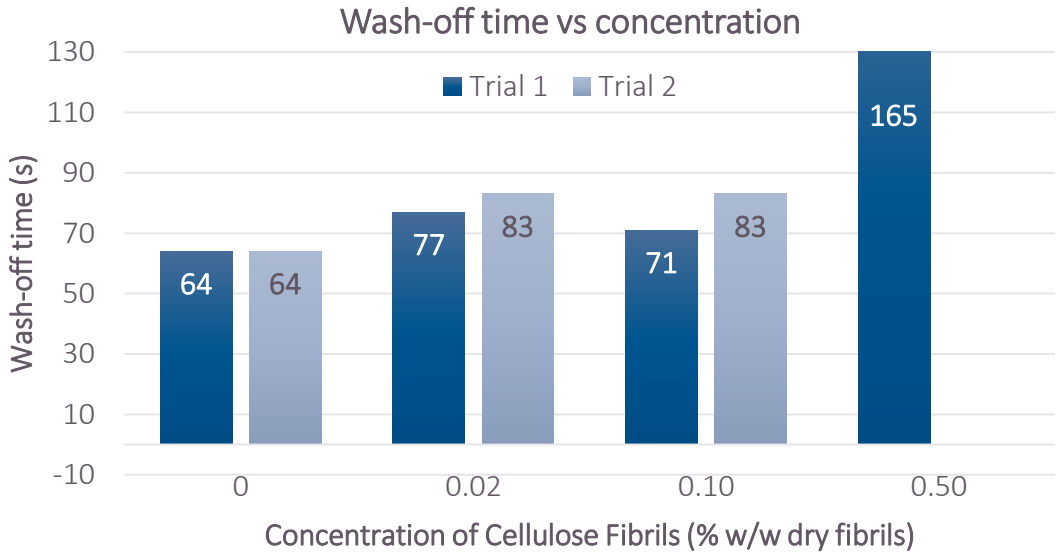
- **Exilva's film forming abilities** – the film can dry homogeneously and prolong the active ingredients residence time on the leaf.

- **Rainfastness test:**
  - Incorporated Exilva into bio-insecticide dilutions (Tank-Mix)
    - Dilute insecticide formulation and add Exilva
  - Deposit 1 drop of formulation on surface (parafilm)
  - Drop allowed to dry at 20°C for 24 hours
  - Measured time to wash off drop from surface

Rainfastness improved with Cellulose Fibrils
(even at 0.02 wt% based on dry)



Cellulose fibrils at 0.2wt% suspended in water sprayed on Pak-Choi leaf



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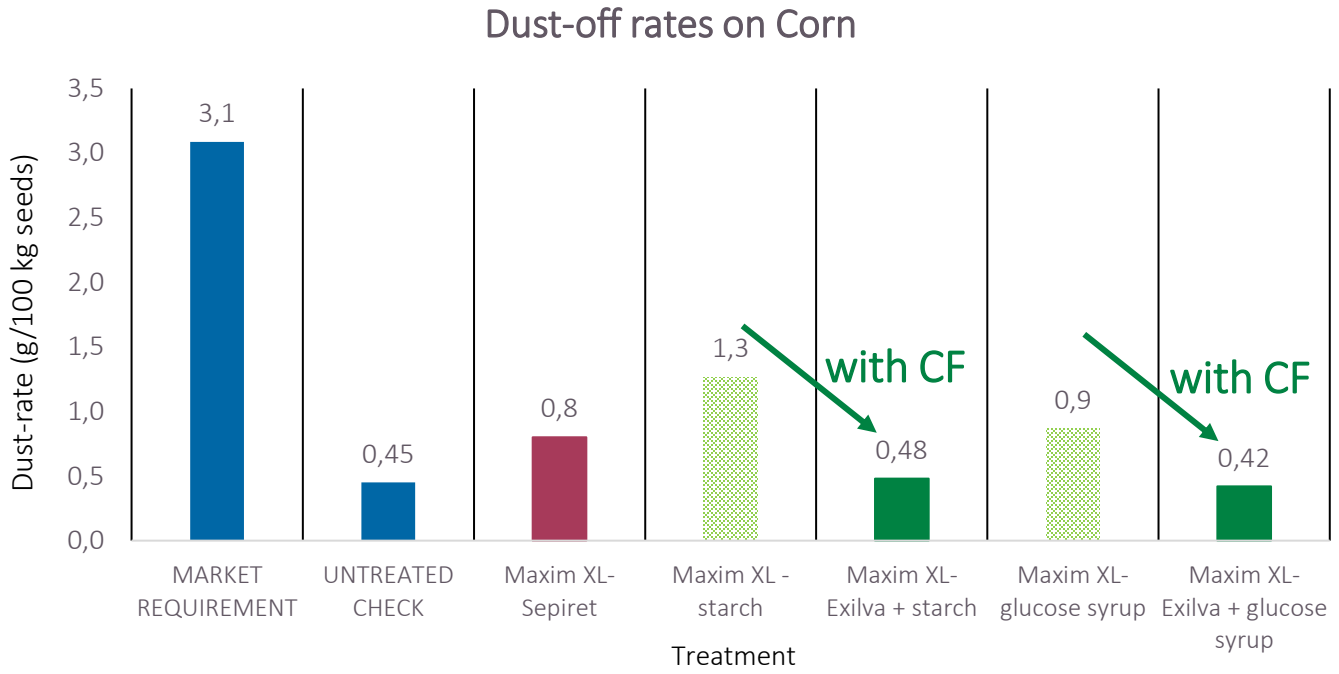
Seed treatment with Cellulose Fibrils

- Corn seeds are treated with a slurry consisting of one of the following:
  - Commercial FS + Commercial seed coat liquid (Polyvinyl Acetate as binder)
  - Commercial FS + Microplastic free seed coat liquid (**Exilva cellulose fibrils** + starch/glucose as binder)

Corn seeds coated with Exilva cellulose fibrils:



- Reduced dust-off by 50-60%, reduced loss of actives, and good germination rate.
- Microplastic free & OMRI compliant seed coatings.

Technical details available in bulletins

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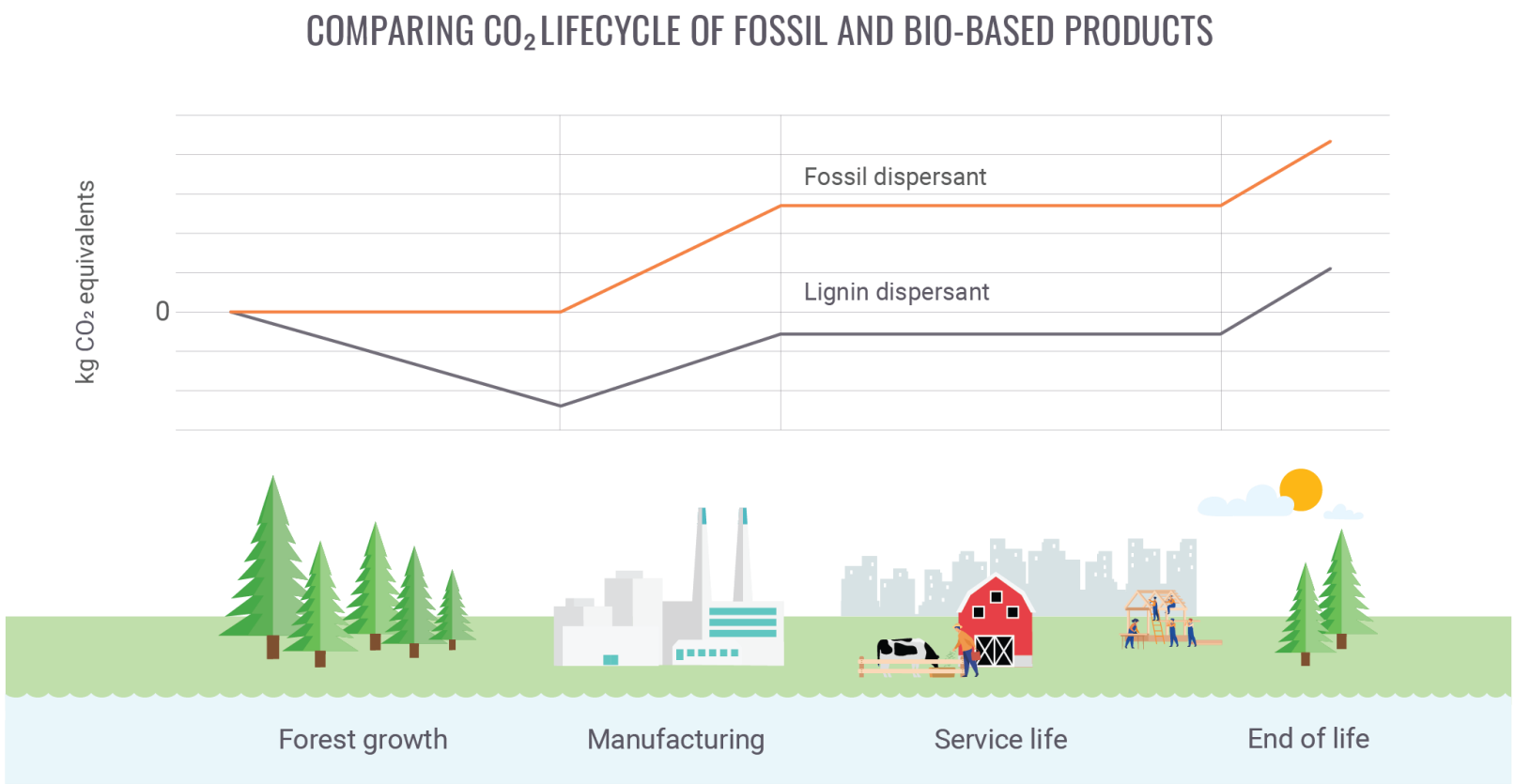
Borregaard – A sustainable solution

Borregaard's products are derived from sustainably managed forests and represent **eco-friendly alternatives to synthetic polymers**



Borregaard's lignin-based biopolymers have a **70 % lower CO_2 footprint** through the overall life cycle compared to a synthetic dispersant.

Borregaard's biopolymers have a **negative CO_2 footprint** during their service life!

Comparison is carried out by the Norwegian Institute for Sustainability Research using life cycle analysis methodology according to the ISO-standards 14040/44. The model substance used as synthetic dispersant is polycarboxylate.

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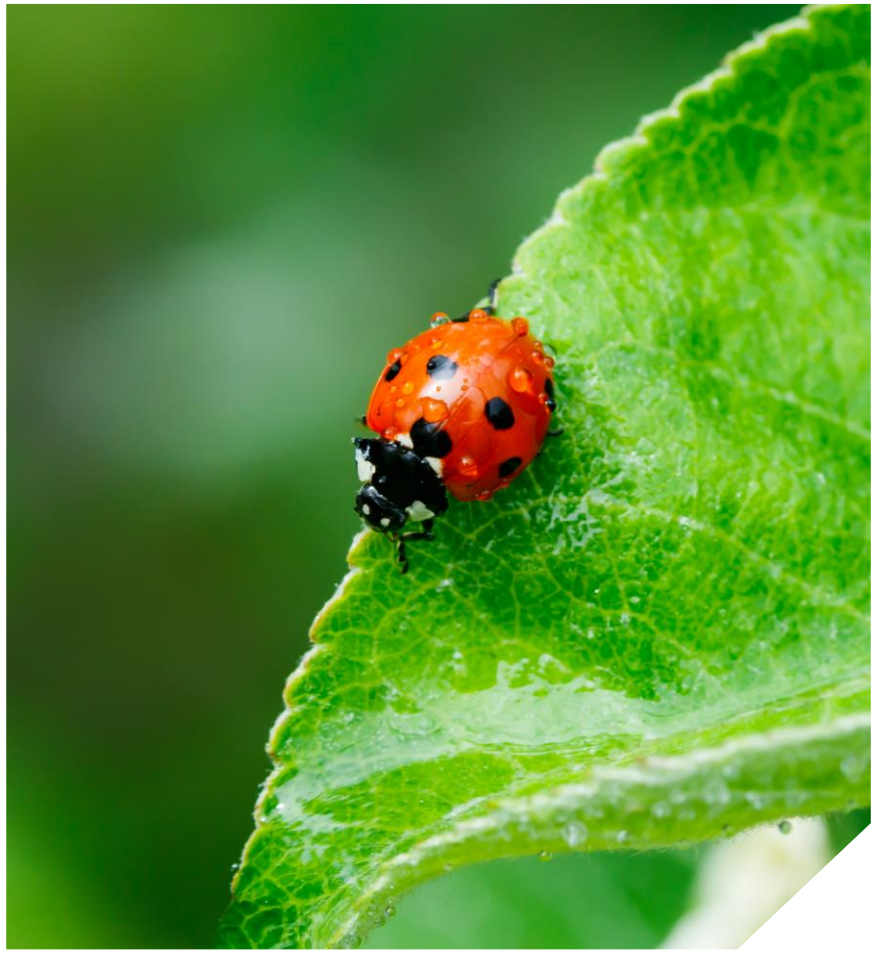
Summary

- Borregaard's lignin biopolymers and Cellulose Fibrils are **bio-based, microplastic free and REACH-exempt**.
  - Lower CO_2 footprint compared to synthetic alternatives
- Lignin Biopolymers showcase **excellent compatibility** with microbes
  - Viability is maintained over prolonged period.
- Activance® UV in a biological formulation
  - **UV-protection**
  - Excellent suspensibility
- Exilva® has film-forming properties
  - **Reduced dust-off** of coated seeds, with good germination rates maintained
  - Improved **rainfastness** of a bioinsecticide with very low fibrils dosage



Thank you

QUESTIONS?

CONTACT THE BORREGAARD R&D TEAM

SCAN ME

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and learn more here

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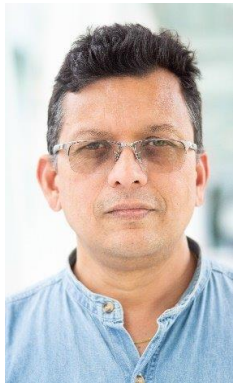

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