

# BioFESAM project : Biocontrol of *Fusarium* Head Blight of wheat

Screening of antifungal activities of spore-forming bacteria, study of their impact from plant protection to food industry process

Klervi CRENN<sup>1</sup>, Céline Hamon<sup>1</sup>, Florence Postollec<sup>2</sup>, Emeline Cozien<sup>2</sup>, Marie-Laure Divanac'h<sup>2</sup>, Anne-Gabrielle Mathot<sup>3</sup>, Adeline Picot<sup>4</sup>, Flora Pensec<sup>4</sup>, Monika Coton<sup>4</sup>, Marie Turner<sup>1</sup>

<sup>1</sup> Vegenov, 1040 Penn ar Prat, 29250 Saint Pol de Léon, France; <sup>2</sup> ADRIA food technology institute - UMT ACTIA19.03, Creac'h Gwen, 29196 Quimper, France; <sup>3</sup> 3 Univ Brest, Laboratoire Universitaire de Biodiversité et Ecologie Microbienne, F-29000 Quimper, France; <sup>4</sup> Univ Brest, Laboratoire Universitaire de Biodiversité et Ecologie Microbienne, F-29280 Plouzané, France

## A 3 step-screening method

### Step 1 : In vitro

Spore-forming strain selection as BCA (Biocontrol Agent)

- Screening of antifungal activity of 100 strains against *F. graminearum* on wheat grain-based media (selection of 12 strains) and wheat grains (selection of 3/12 strains)
- Other parameters studied : taxonomic confirmation, enzymatic screening

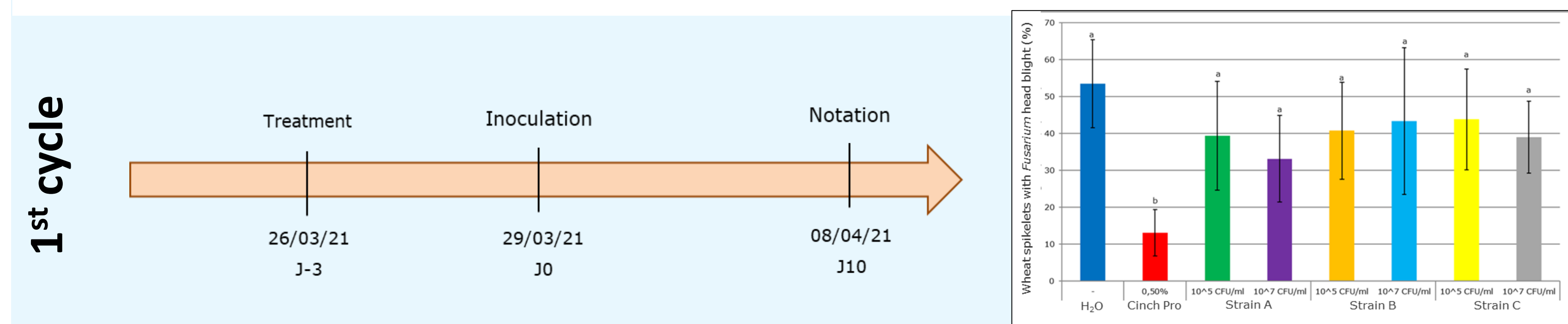


Figure 1 : Scale evaluation of *in vitro* *F. graminearum* growth (a) and *in vitro* screening of bacterial strains against *F. graminearum* on wheat grain-based medium (b). Evaluation of a bacterial strains on surface-disinfected wheat grains, with an active strain showing antifungal activities (c). *In planta* evaluation of spore-forming bacteria in regulated growth chamber (d).

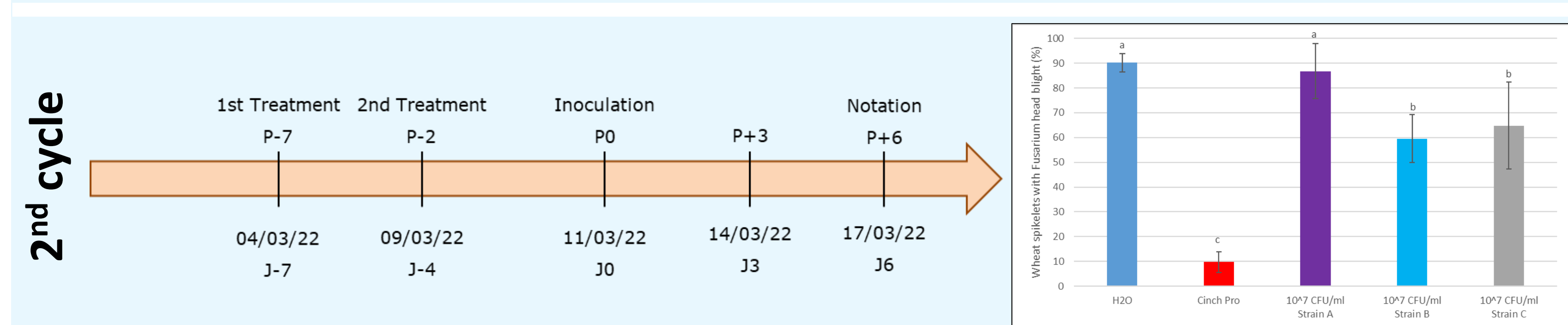
Table 1 (below) : Description of the 3 spore-forming strain candidates for biocontrol of *Fusarium* head blight of wheat. Informations in green, orange and red correspond respectively to advantages, neutral and disadvantages characteristics of the strains

	Taxonomy	Growth at 20°C	Origin	Isolation date	Enzymatic activities										Hemolysis	Surfactant	Biofilm	Growth rate (h-1)	Biomass (log <sub>10</sub> UFC/mL)	Spore % at 48h	Spore speed	Method tested for spore production		
					Amylase	Starch	Gelatin	Casein	Tributyrin	Tween 80	Lecithinase	Chitin	Cellulose	Pectin								Rich media (biomass) → deficient media (sporulation)	Media HCT (Lereclus et al., 1982)	Solid media (Okhubo et al., 2019)
Strain A	<i>Bacillus paralicheniformis</i>	++	Plant	2013	-	1,3	1,9	1,5	0	1,1	-	0,7	4,2	2,9	0,0	weak	2,4	0,6	8,0	58	High	6,56.10 <sup>9</sup>	1,68.10 <sup>9</sup>	1,3.10 <sup>10</sup>
Strain B	<i>Paenibacillus odorifer</i>	++	Meat product	<2008	-	1,1	2,0	2,8	0	1,3	+	0	2,2	2,2	0,0	weak	0,8	0,6	7,8	63	Medium	9,2.10 <sup>6</sup>	8,50.10 <sup>7</sup>	1,7.10 <sup>8</sup>
Strain C	<i>Paenibacillus polymyxa</i>	++	Dairy product	1985	-	1,1	2,0	2,7	0	0,6	-	0	3,0	2,6	0,0	weak	0,1	0,5	7,7	89	High	3,32.10 <sup>6</sup>	5,10.10 <sup>7</sup>	1,3.10 <sup>8</sup>

### Step 2 : In planta



- No plant protection
- A small dose-effect is observed with strain A



- Plant protection of strains B and C
- with 34 and 28% effectiveness (compared to H<sub>2</sub>O)
- qPCR detection indicates that cell concentration increases for the three strains up to 8.10<sup>7</sup> cells/ear for strain A, and 1 to 1,5.10<sup>6</sup> cells/ear for strains B and C at day 3 or 6.

### Step 3 : In silico

Survival of candidate BCA strain from field to fork - a case study from grain to bread

- Growth cardinal values & spore heat resistance determination
- Simulation of bacterial survival or growth along process & shelf life for several scenario to assess safe use of potential biocontrol strains (Sym'Previus)

➔ No survival of strain A during molded bread baking

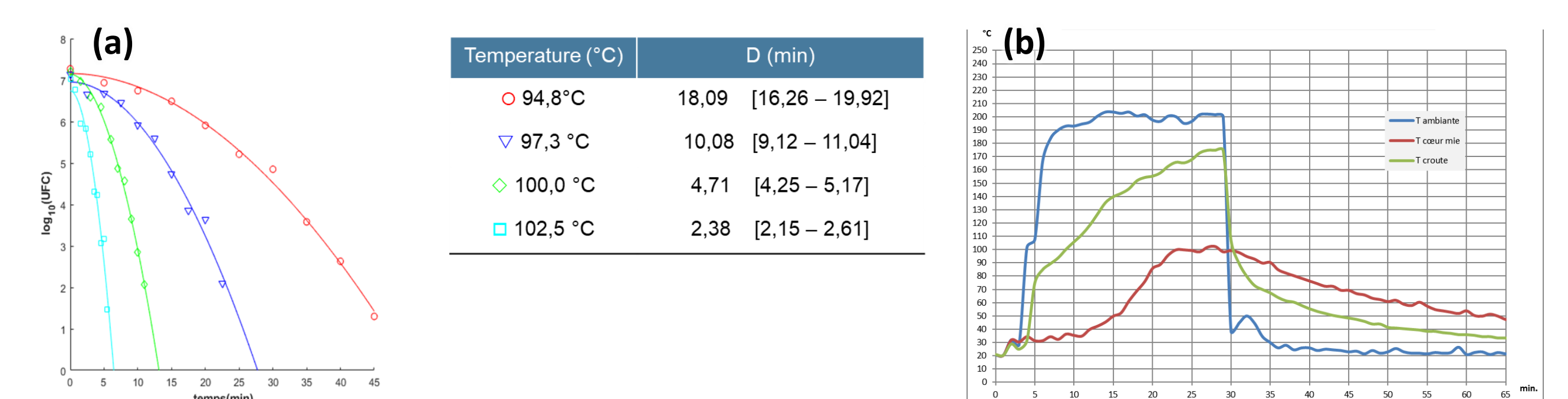


Figure 3 : Results concerning the thermoresistance of strain A (a) and temperature registrations for 350g molded bread baking (b).

## Conclusion :

- 2 BCA candidate strains moderately efficient (about 30% for *in planta* trials) to control *Fusarium* Head Blight of wheat
- No toxicological issues (enzymatic tests)
- No survival of a close related strain during molded bread baking

## To go further ...

- Strain effectiveness improvement (formulation, production, etc.)
- *In silico* study on strains B and C
- Looking for partners to continue exploring the potential of these strains

## Consortium complementarity : from field to fork



Duration  
3 years  
(2019-2022)



Budget  
72,9k€



### Expertise in plant protection and biocontrol product evaluation

- Regulated growth chamber and greenhouses for *In planta* trials
- Molecular biology lab for microorganism detection on plant



### Expertise on spore forming bacteria diversity, risk assessment and biocontrol of *Fusarium* Head Blight of cereals

- Spore forming bacteria collection, mainly isolated from food
- Spore production & culture
- Characterisation of bacterial growth, enzymatic, bioadhesion and resistance ability
- Bacterial molecular identification & typing
- Food inoculation and validation of process and shelf life using predictive microbiology to assess destruction, survival or resistance of strain along food processes and shelf-life
- Screening of antifungal activity on wheat grain-based medium and wheat grains
- Mycotoxin quantitation on various matrices

