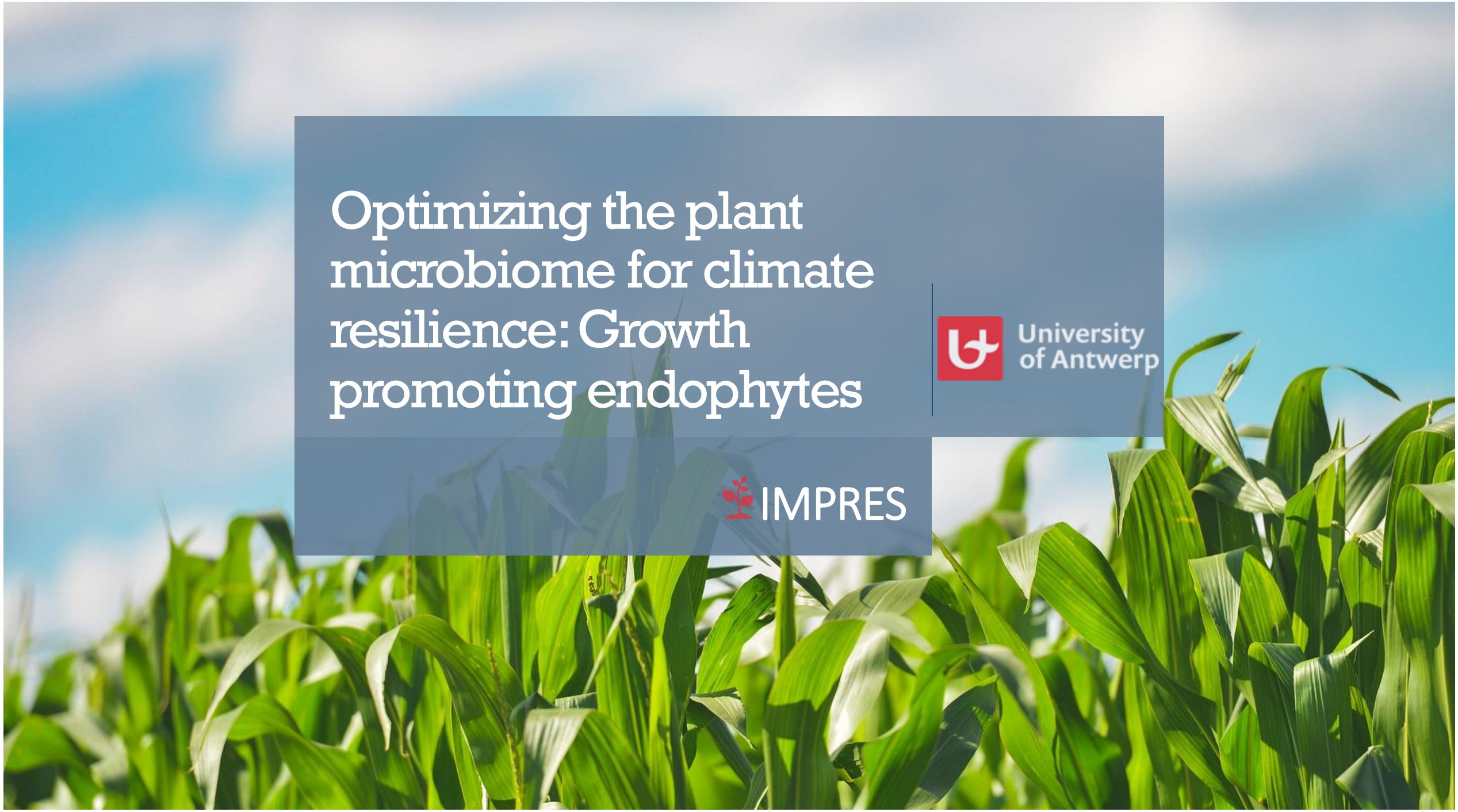
Optimizing the plant microbiome for climate resilience: Growth promoting endophytes

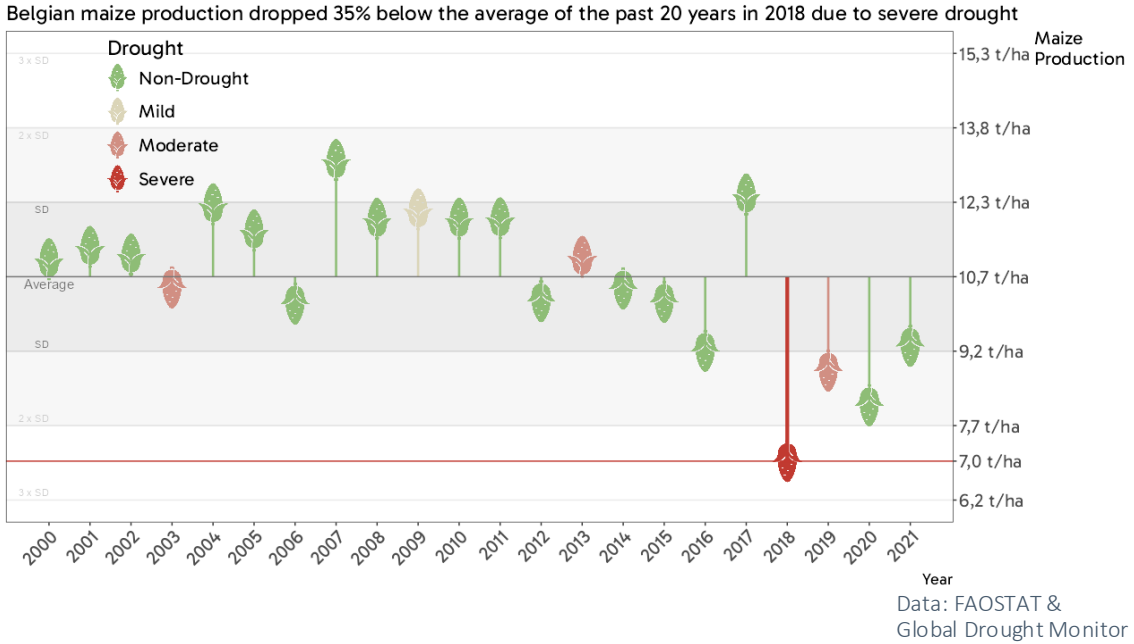
University of Antwerp

IMPRES



Studying endophytes under drought in maize

- An **endophyte** = an endosymbiont, often a bacterium or fungus, that lives within a plant without causing apparent disease
- They have often proven to be a valuable solution to promote plant growth under different conditions
- Due to **climate change**, drought frequency and intensity are set to increase
- Severe drought can greatly impact maize yield
- **The goal of this research project is thus to elucidate the positive effect some endophytes have on maize growth under drought stress**
- **Research interests**
  1. How are different processes affected at the plant-level?
  2. Do these endophytes act in a specific plant tissue?



Data: FAOSTAT & Global Drought Monitor

General *in planta* experiments and analyses

- Main experiments and analyses at our lab
  - **Kinematic analysis**
    - Provides information that allows for strategic sampling of the important tissues to study the interaction in more detail
  - **Transcriptomic analysis**
    - Provides information on gene up-/downregulation under specific conditions
  - **Validation experiments**
    - Verifies hypotheses usually made based on transcriptomic analysis
    - Can include quantification of enzyme activity, ROS, and various compounds; use of mutant maize lines,…

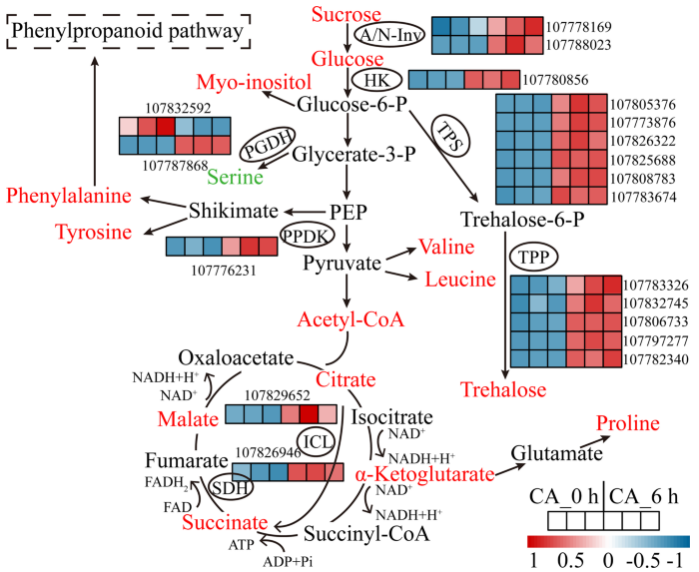
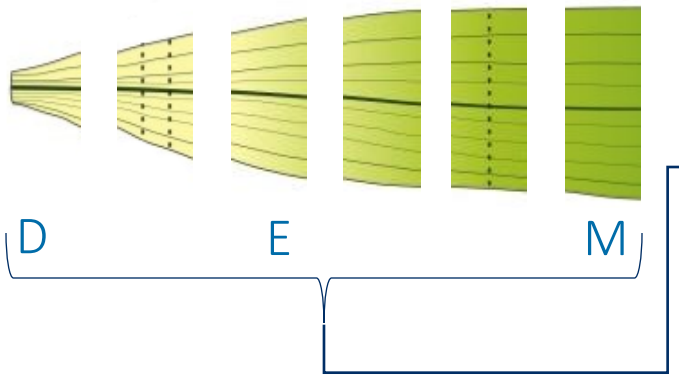
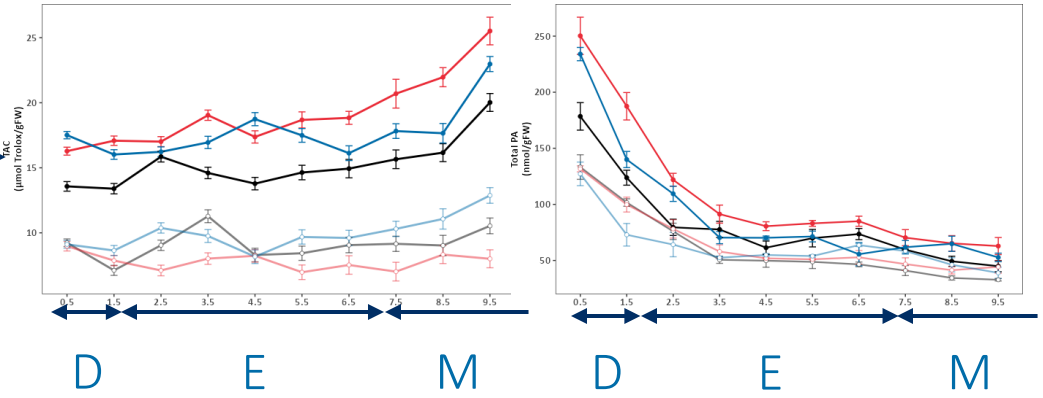


Image from Xu et al. (2020) illustrating the use of transcriptomics to study the effect of cold in tobacco



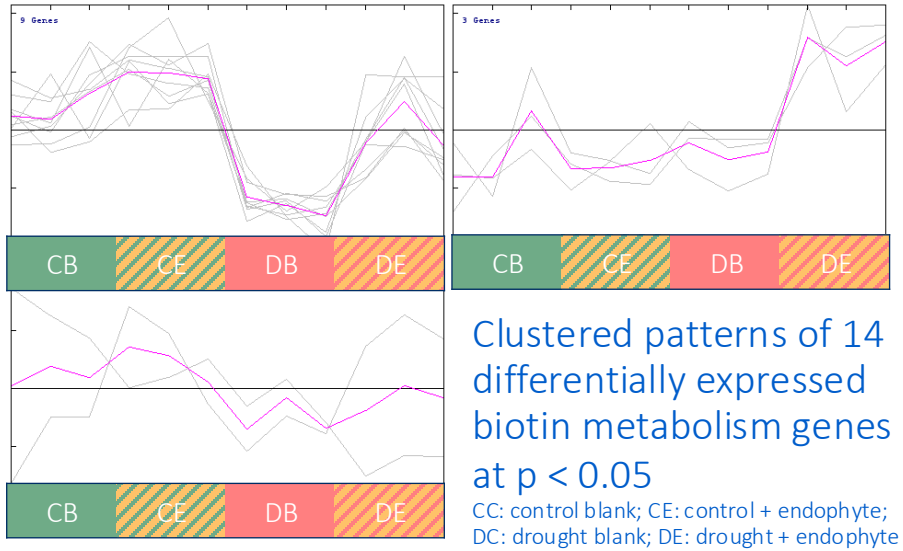
Study zone-specific effects in the maize leaf



Colour-based assays to perform various quantifications using a platereader

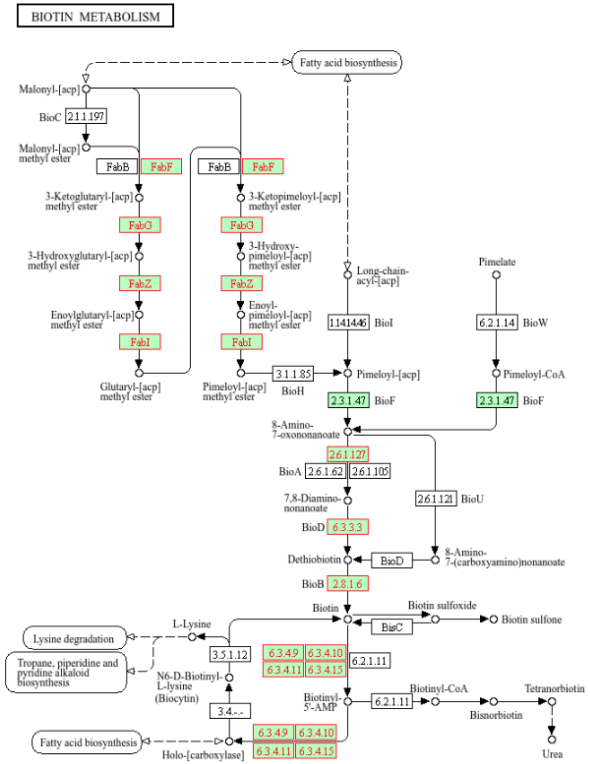
Key results to further explore

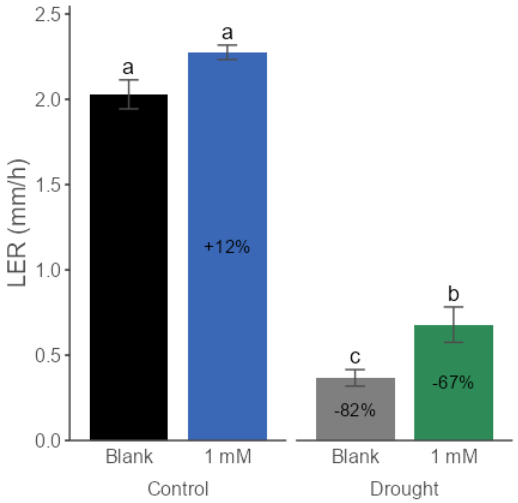
- Our **fungal strain ESALQ1307** has shown to specifically upregulate **biotin metabolism** *in planta*, as was found through transcriptomic analysis
- In a proof-of-concept experiment, we could observe that adding biotin to drought-stressed maize plants could improve the **leaf elongation rate** (LER; proxy for maize growth)



Clustered patterns of 14 differentially expressed biotin metabolism genes at $p < 0.05$

CC: control blank; CE: control + endophyte;
DC: drought blank; DE: drought + endophyte

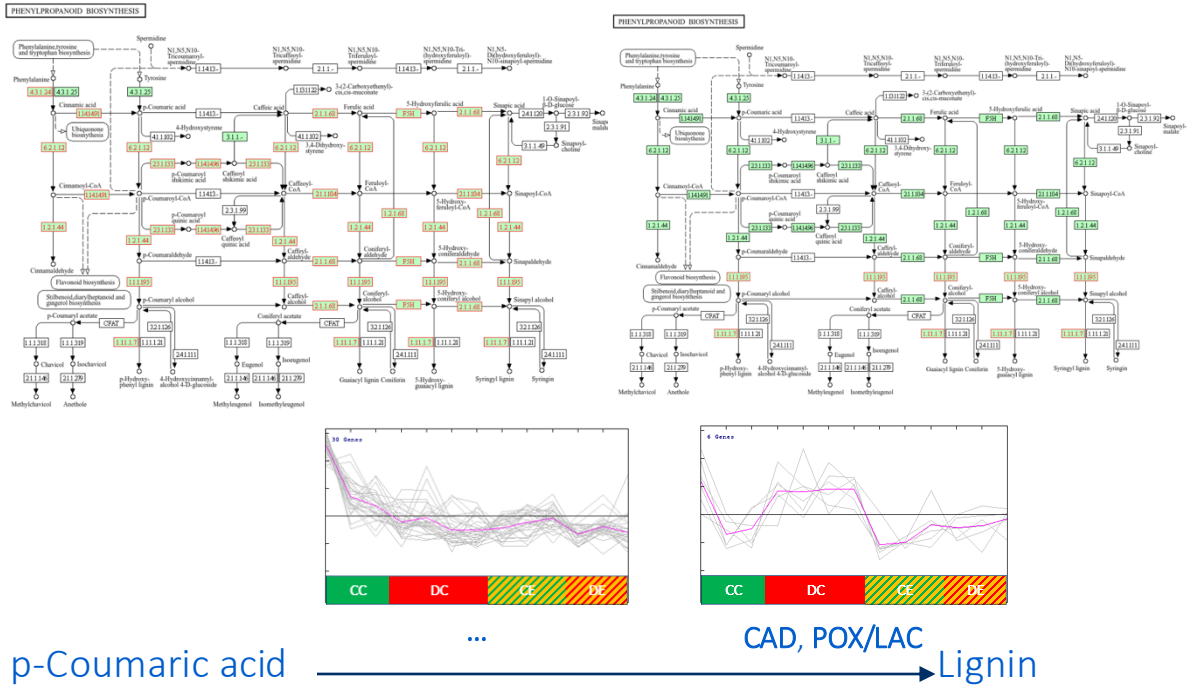




- Currently, we are genotyping and screening **maize mutants** (impaired in biotin production) in their growth response to drought stress
- We also intend to quantify biotin content of these mutants and of fungus-inoculated plant material, using **UPLC-MS**

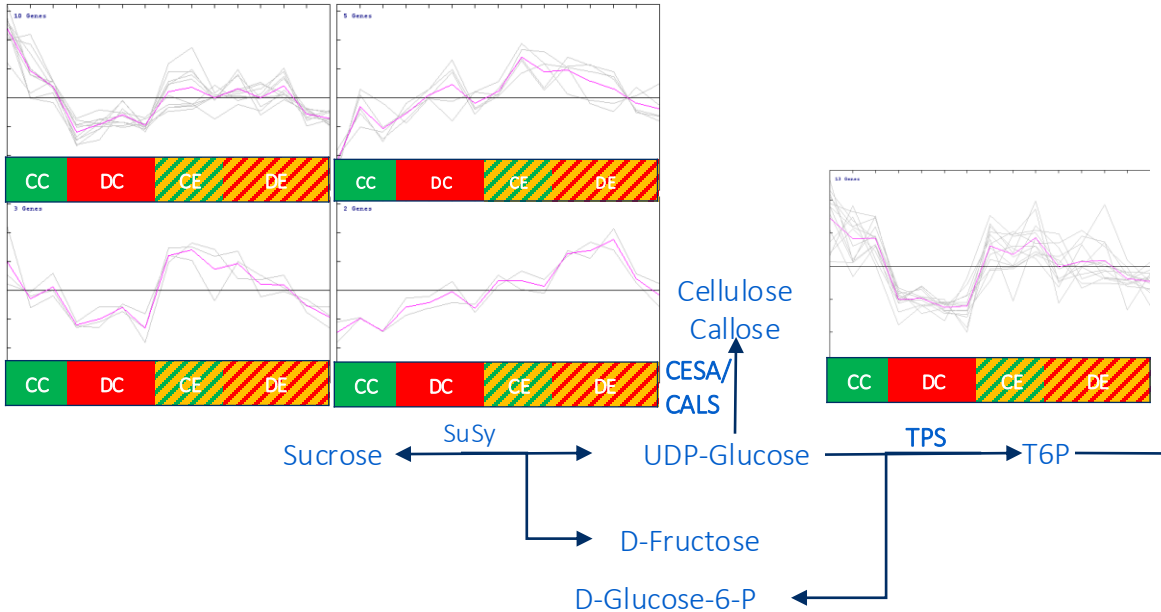
Key results to further explore

- Three **bacterial strains 327, 571 and BR5**
  - Obtained through collaborations with a Chinese university
- From transcriptomic analyses, we have proposed a hypothesis for each strain
  - 327: affects **lignin** production
  - 571: affects **trehalose-6-phosphate** synthesis and **cell wall** production
  - BR5: produces **cobalamin**



Downregulation of lignin production by endophyte 327

Upregulation of cell wall and T6P production by endophyte 571



- We are planning to perform an **untargeted metabolomics analysis** for each of these treatments
- We are planning to perform genotyping and screening of **maize mutants** (impaired in lignin production, cellulose production and T6P production) in their growth response to drought stress

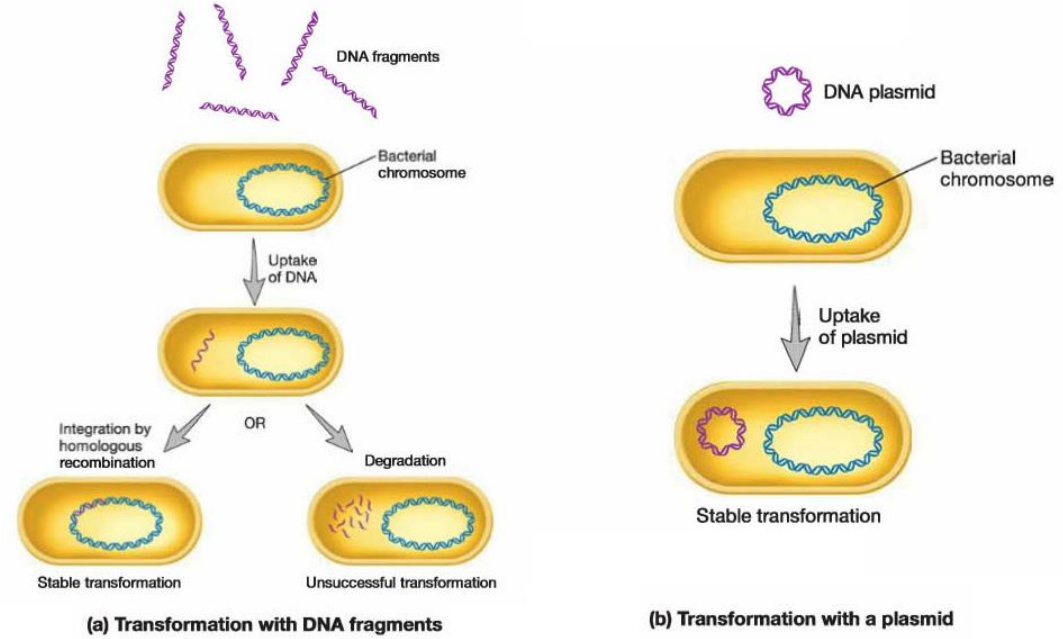
Planned localisation experiments

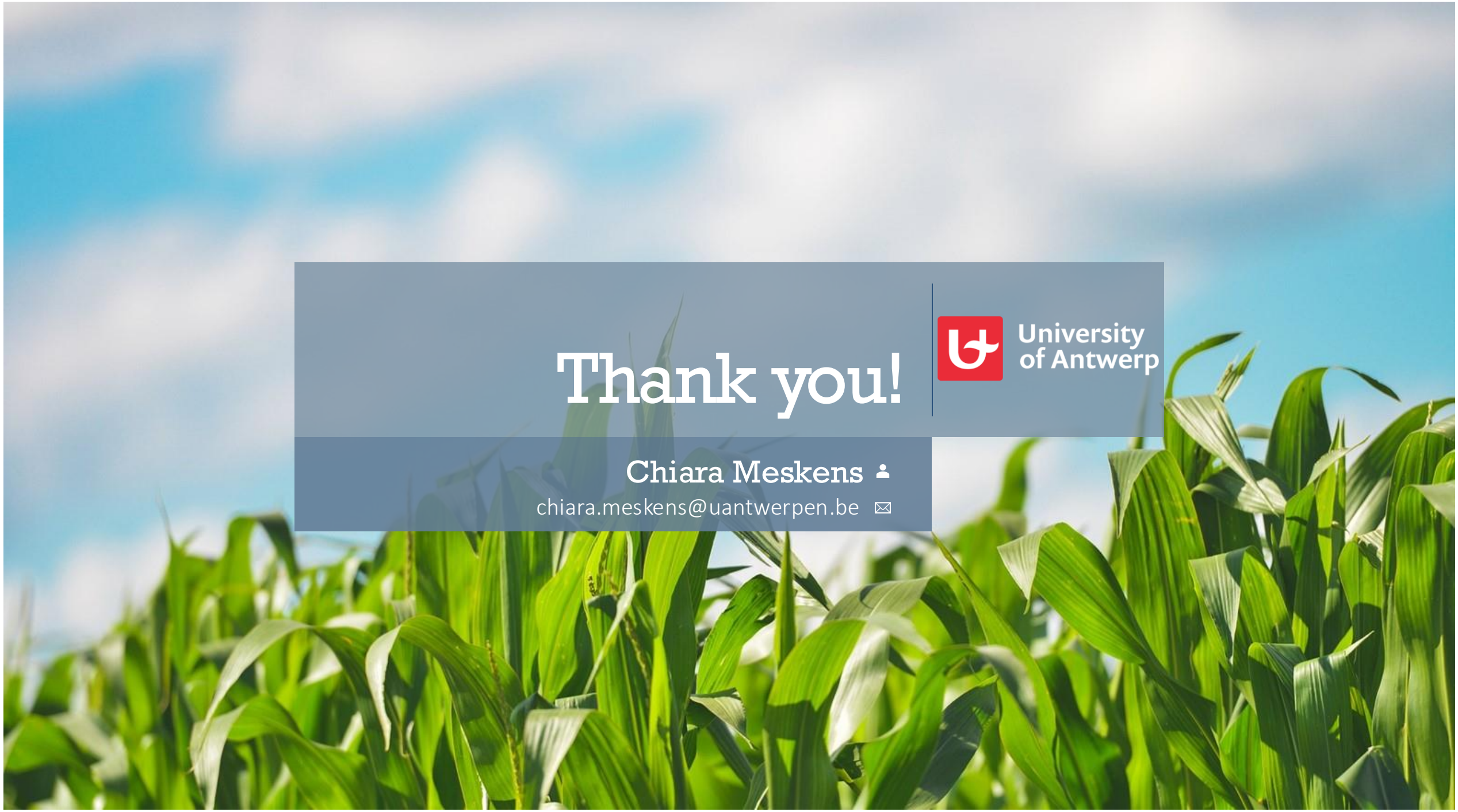
- Our bacterial strains **E7 and E14**
  - Obtained from a collection of microbes extracted from grasses grown in arid environments through collaborations with universities in Egypt and Saudi-Arabia
- **Fluorescent labelling** of the two strains to obtain information on (sub-cellular) localisation and abundance *in planta*
  - Bacterial transformation
  - Colonization experiments
  - Fluorescence microscopy
  - Quantification using qPCR

Bacterial transformation is currently being optimised in order to create fluorescently labelled strains

Fluorescence microscopy

Quantification using qPCR




Thank you!
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