

Genome 20+2 Workshop

Paulo Arruda



GCCRC

*Genomics for Climate Change
Research Center*

FAPESP Genome program

Xylella fastidiosa genome sequencing project

- Start sequencing 1998
- Nature 2000

The genome sequence of the plant pathogen *Xylella fastidiosa*

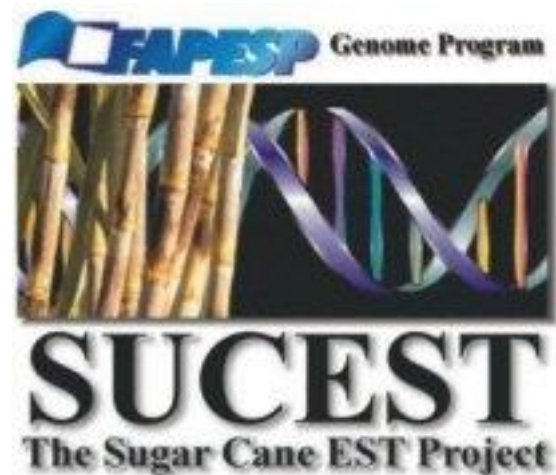
The *Xylella fastidiosa* Consortium of the Organization for Nucleotide Sequencing and Analysis*, São Paulo, Brazil



Sugarcane EST sequencing project (SUCEST)

- Start sequencing 1999
- Genome Research 2003

Analysis and Functional Annotation of an Expressed Sequence Tag Collection for Tropical Crop Sugarcane

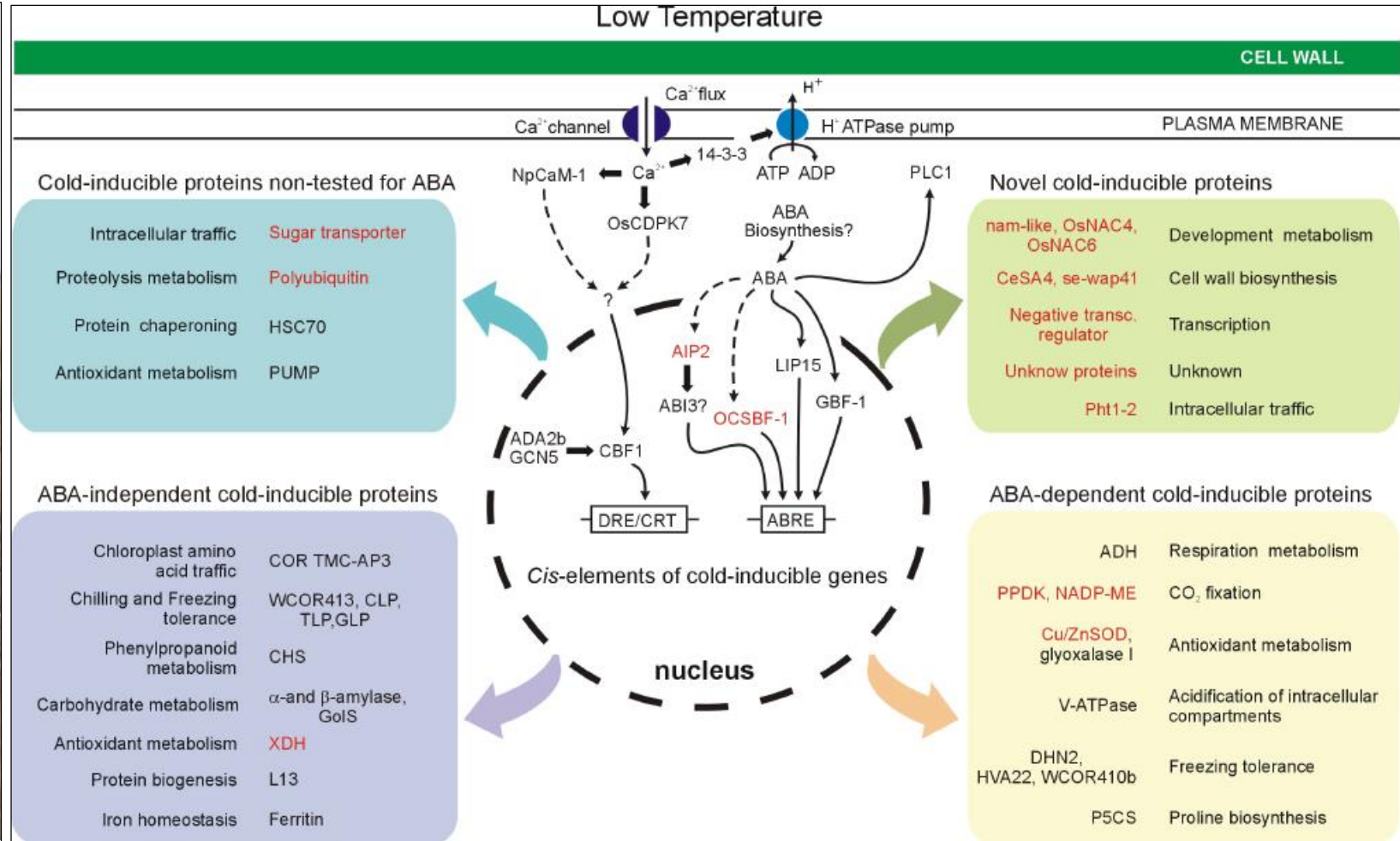


Look at SUCEST and find your favorite gene

Sugarcane field after frost

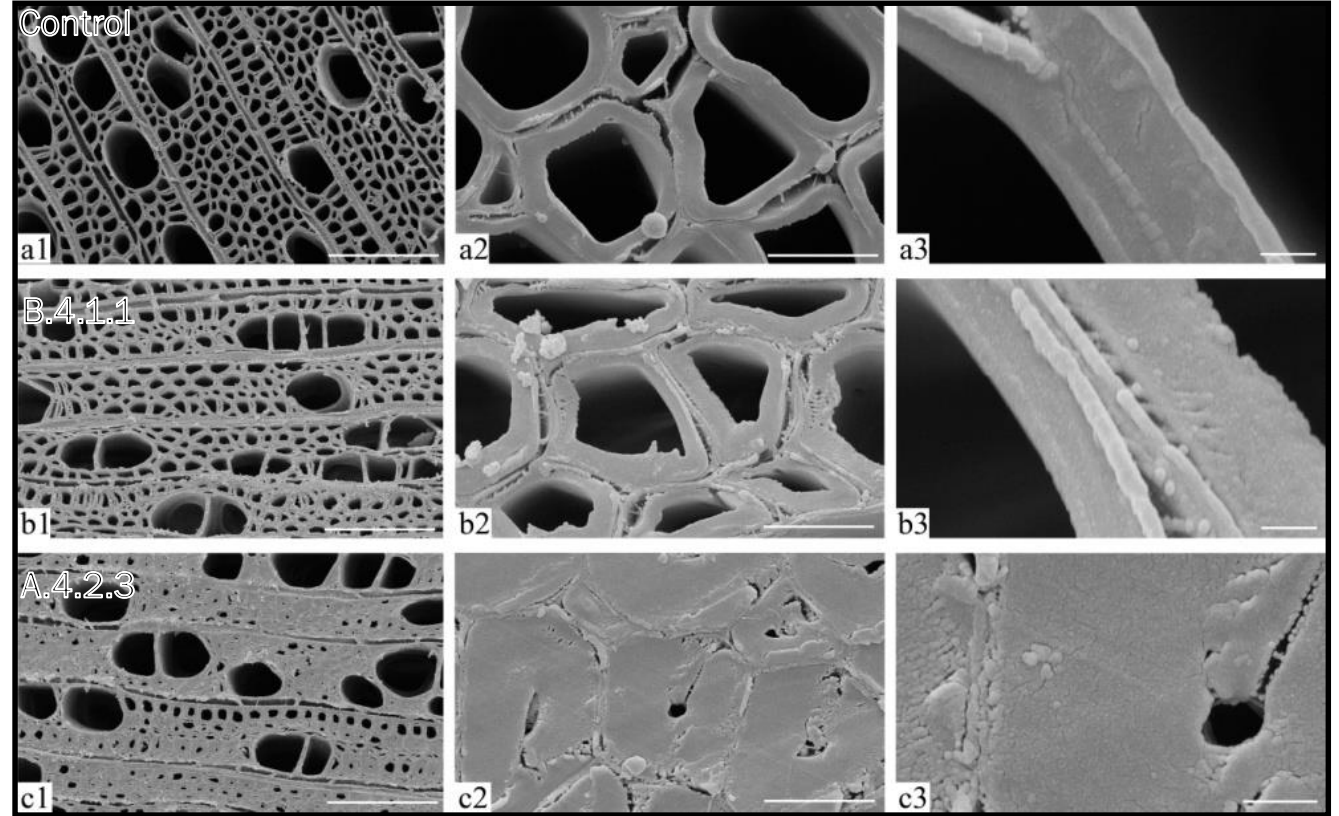


Genomics of sugarcane response to low temperature



Late 2002: Startup Alellyx Applied Genomics

Wall of a transcription factor that regulates cell wall deposition



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 February 2010 (25.02.2010)

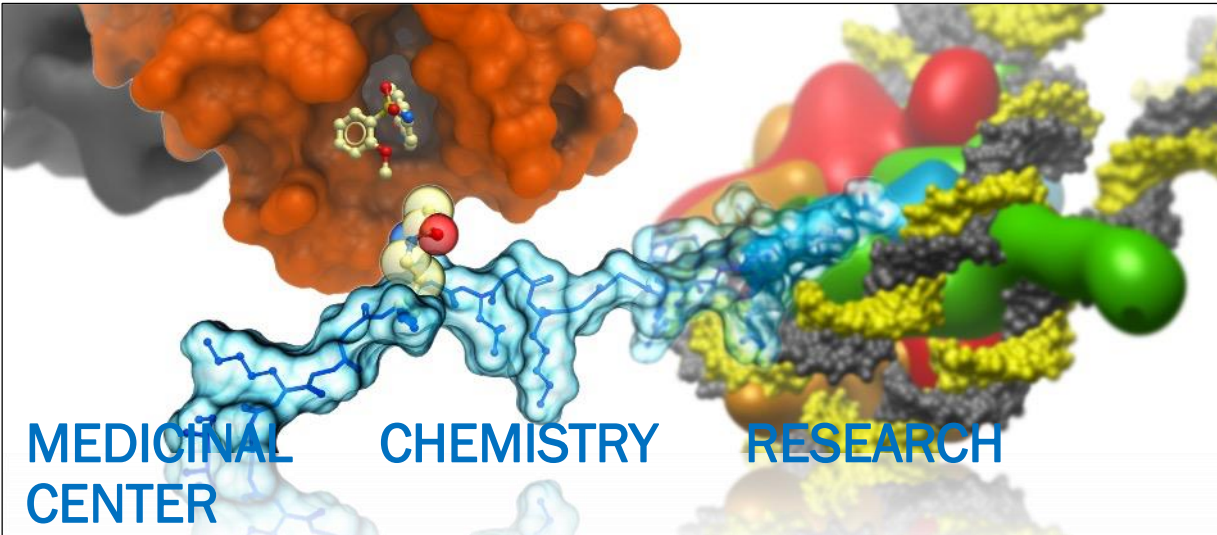


(10) International Publication Number
WO 2010/020868 A3

2009 – Back full-time professor at Unicamp

Genomics Hub for Health and Agriculture

2015 - on



MEDICINAL CHEMISTRY RESEARCH CENTER

A partnership between UNICAMP and STRUCTURAL GENOMICS CONSORTIUM
Funded by FAPESP –PITE, INCT, EMBRAPII

2016 - on



GENOMICS FOR CLIMATE CHANGE RESEARCH CENTER

A partnership between UNICAMP and EMBRAPA
Funded by FAPESP – CEPE

Logos for GCCRC, Embrapa, and FAPESP are visible.

Medicinal Chemistry Research Center



About CQMED

Since 2015

- Partnership with Structural Genomics Consortium

Since 2017

- INCT (OpenMedChem)
- Embrapii Unit (CQMED)

Atualmente

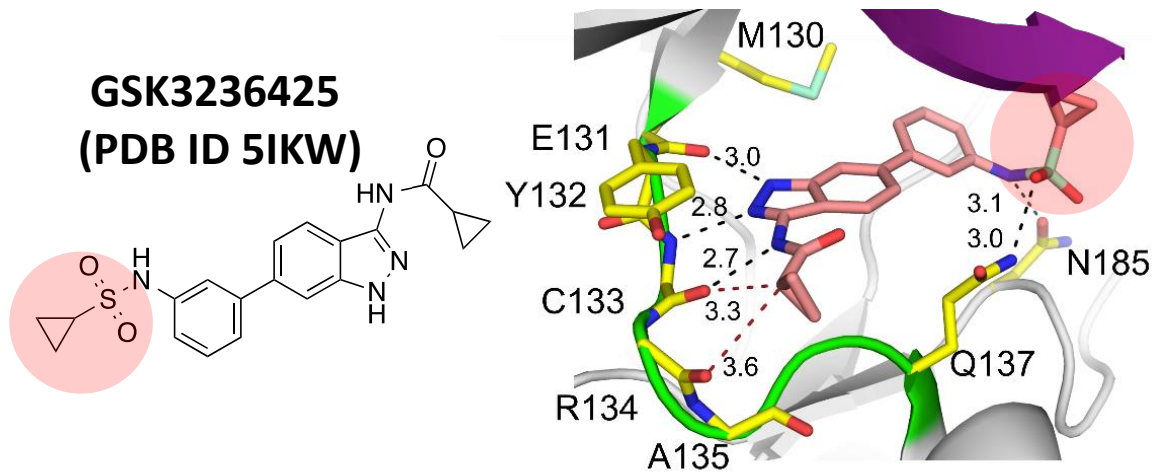
- 5 PIs
- 18 pós-docs
- 4 Admin + 1 TI
- 5 Technician
- 340m² Lab space



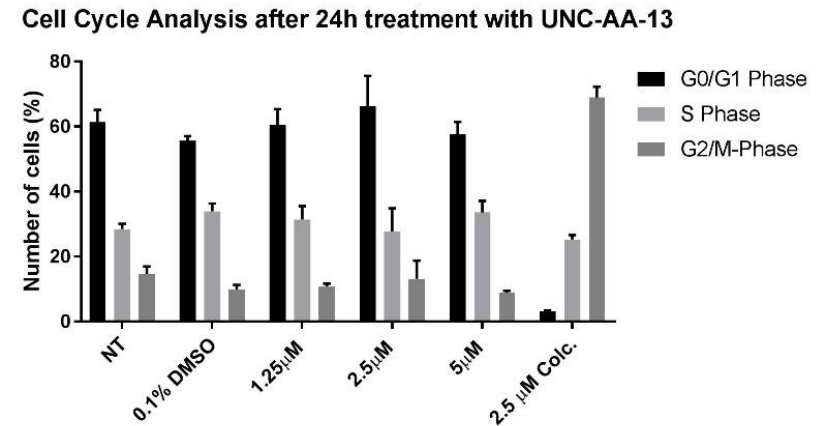
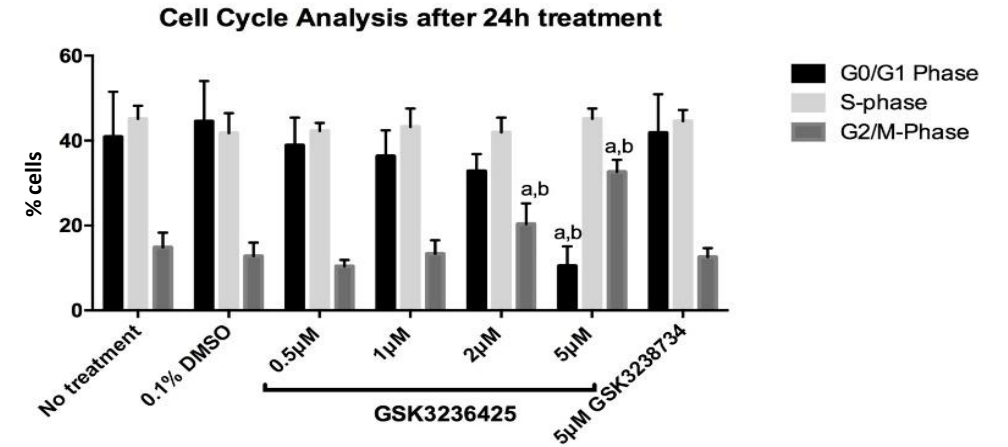
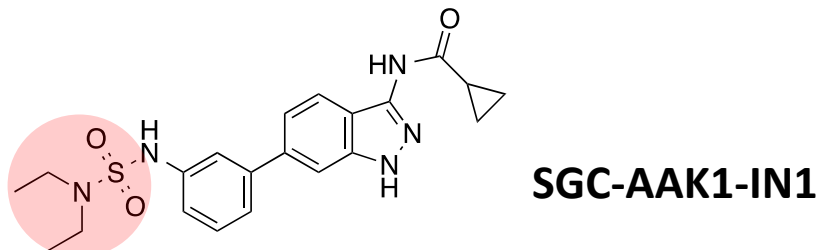
CQMED – From Gene to Probe

Development of a chemical probe for Adaptor Protein 2 Associated Kinase 1 (AAK1)

Template compound – potent, but toxic



CQMED Probe – potent, non-toxic



Cell Reports

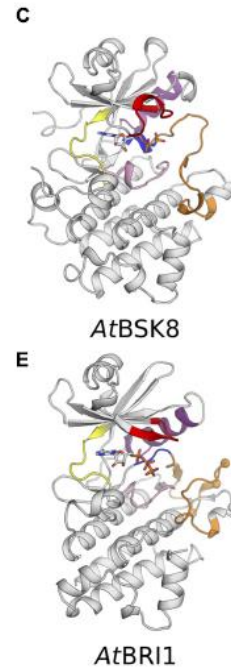
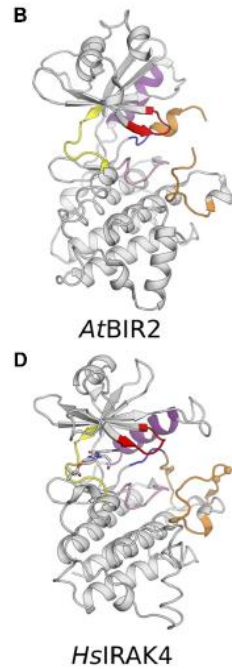
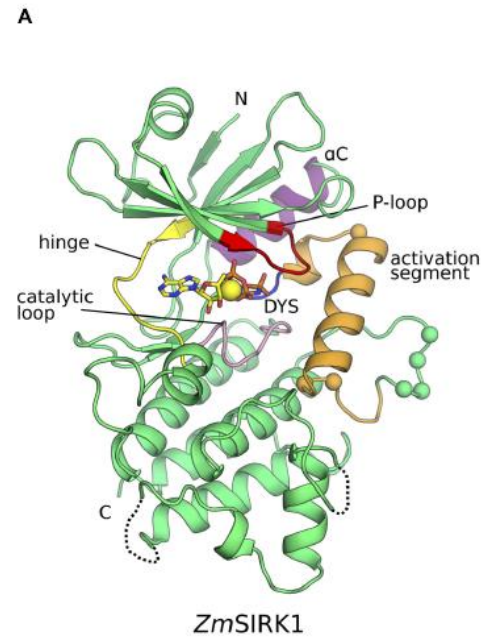
WNT Activates the AAK1 Kinase to Promote Clathrin-Mediated Endocytosis of LRP6 and Establish a Negative Feedback Loop

ARTICLE

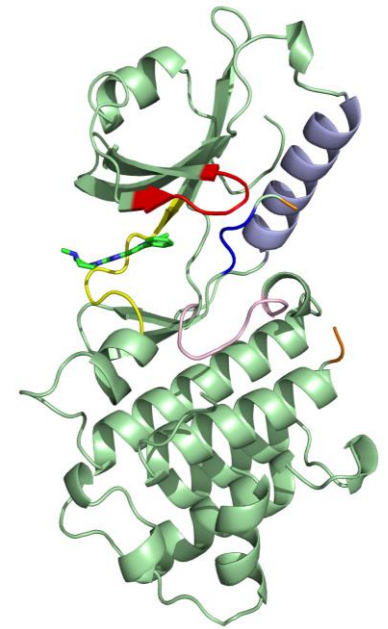
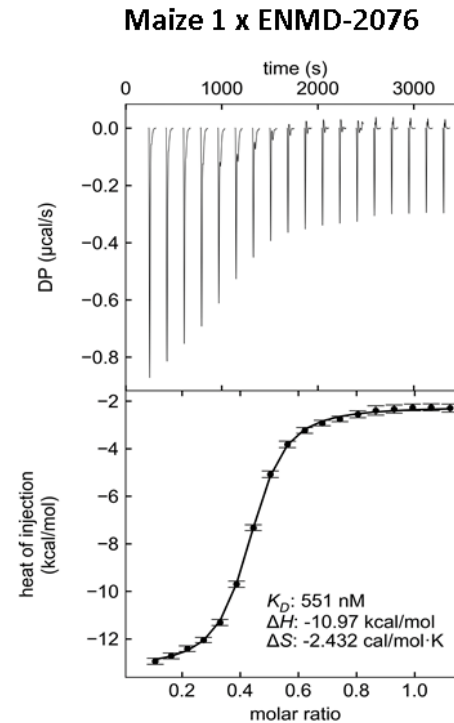
Genomics Hub for Health and Agriculture

Examples: Cristal structure of maize kinases associated with drought stress response

ZmSIRK1



ZmKin1





GENOMICS FOR CLIMATE CHANGE RESEARCH CENTER

A partnership between UNICAMP and EMBRAPA
Funded by FAPESP _ CEPE



What are the sources of energy for humans



Carbohydrates

Cereals, legumes and fruits



Fat

Leguminous plants



Proteins

Milk, meat, eggs, fish

Carbohydrates, fats, and proteins account for **80-90%** of the energy we consume, and are directly or indirectly derived **from 5 crops**

Rice



Maize



Wheat



Soybean



Sugarcane



The dilemma of food security



925.000

Years of historical food production should be achieved in the next 50 years

People currently hungry

70%

Of the fresh water available in the planet is used for food production

40%

World employment is in agriculture

30%

Greenhouse gas emissions are related to agriculture (16% deforestation)

20%

Increase in production, reduction of gas emissions, reduction of rural poverty

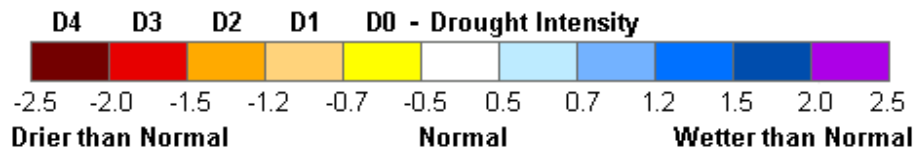
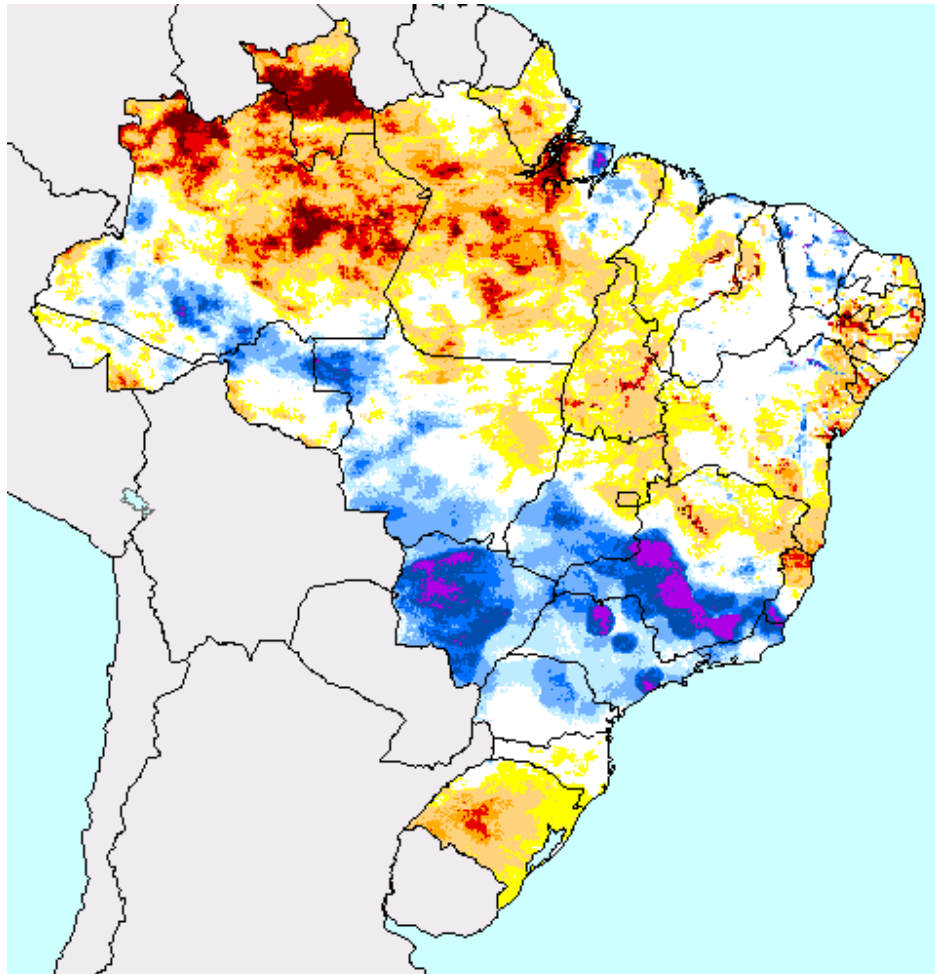
Challenge: To produce more with less (fertilizers, pesticides, water)

There is a need to increase productivity by **60%**

To meet the demand for food of the world population by 2050



But how to increase crop productivity under the threat of climate changes



Effect of drought on the 2015/2016 corn crop

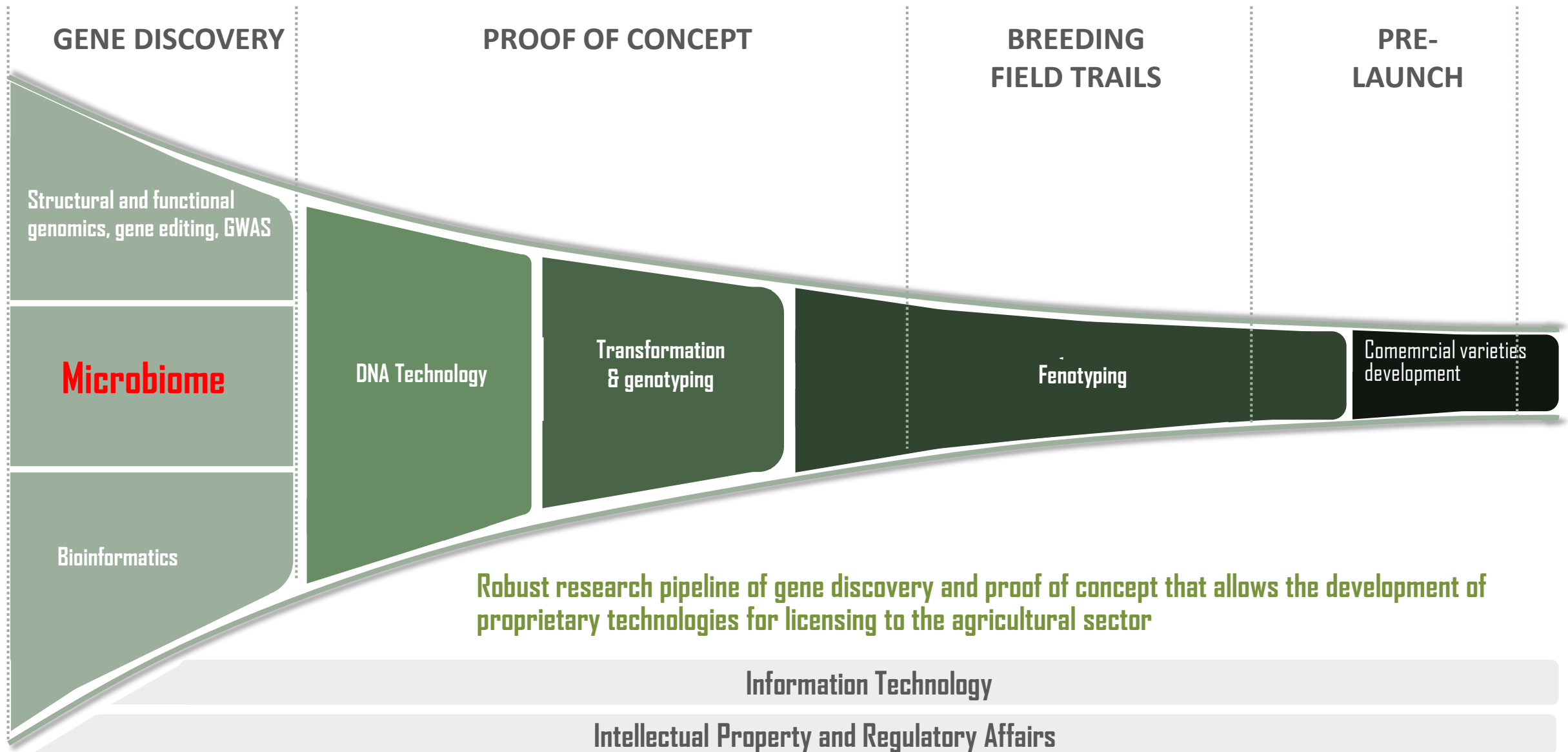


Drop in production equal to the annual average of Mato Grosso (largest national producer)

18MMt

Loss of R\$ 11 Billion

The GCCRC "From Gene to Trait" platform



Where are the genes for drought stress?



Genomics of the Campos rupestres: A source of genes for drought tolerance and phosphorus acquisition

Velloziaceae exhibit desiccation tolerance (reviving species; e.g. *Vellozia nivea*) and hydration maintenance ("evergreen" species; e.g. *V. intermedia*).



Late rain season



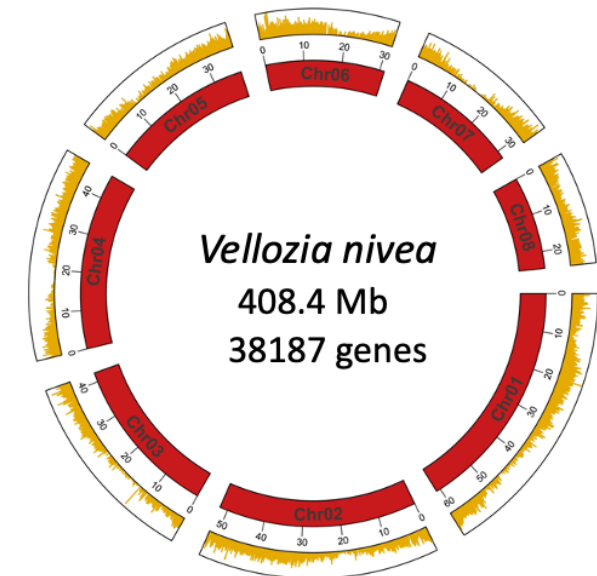
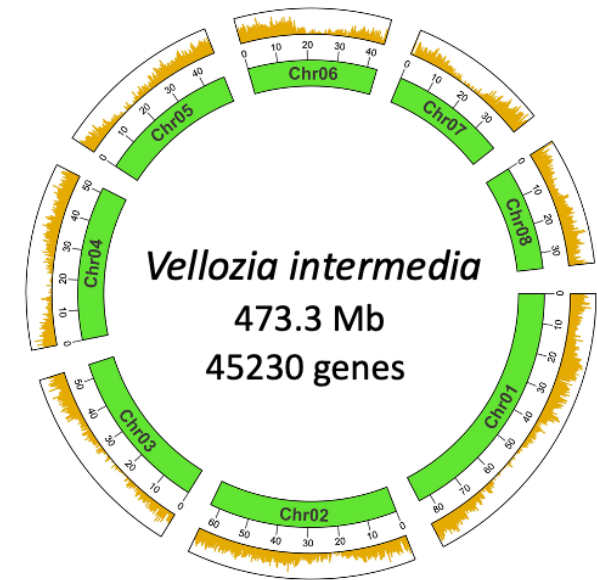
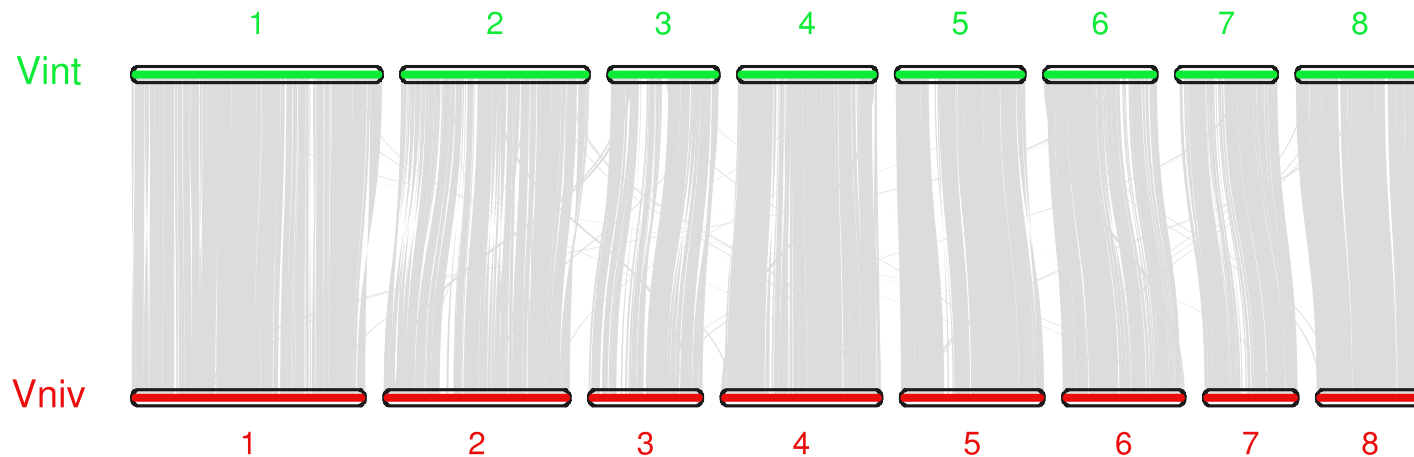
Late drought season



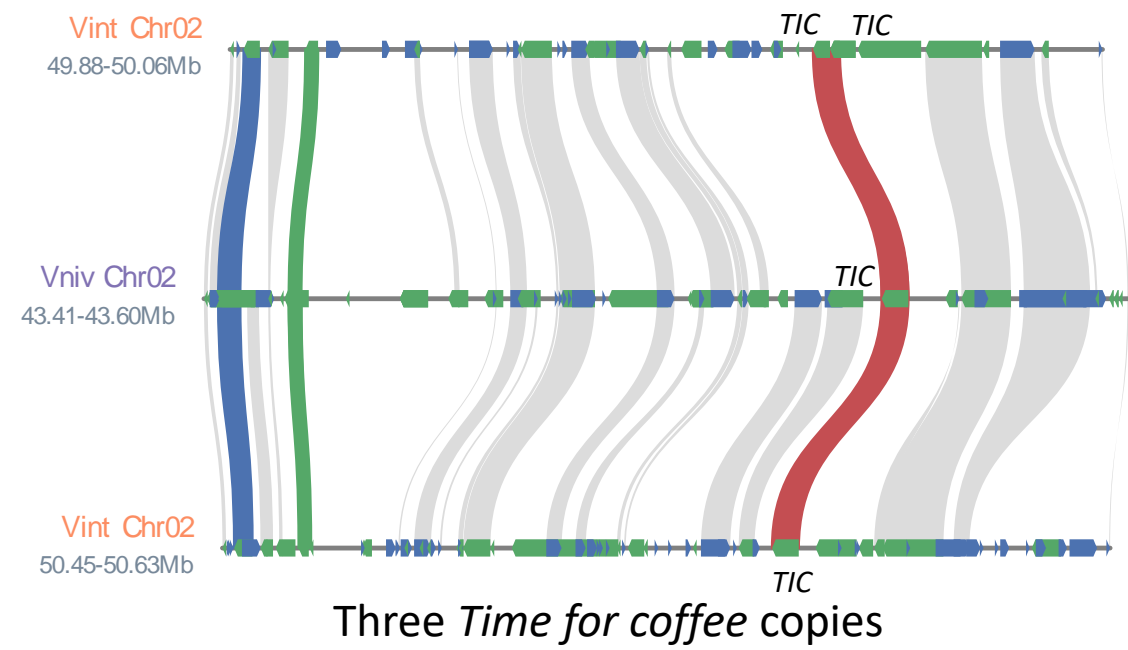
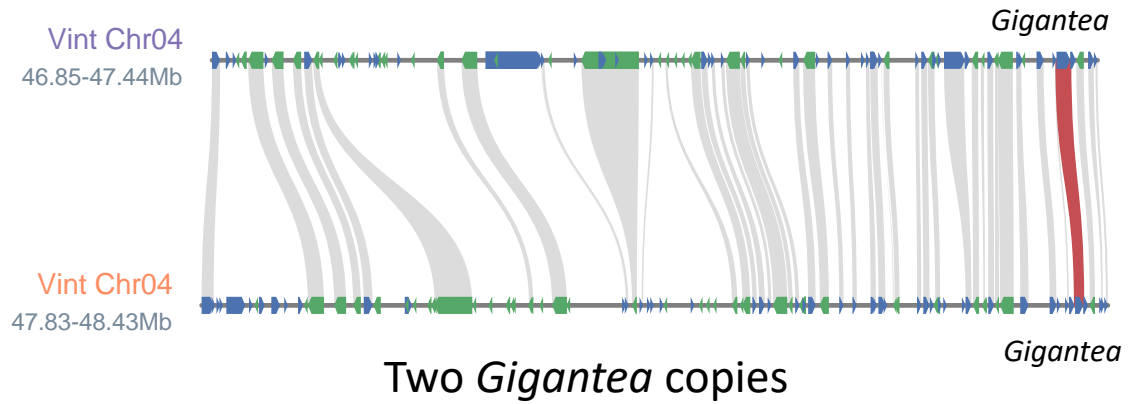
Chromosomal level genome assembly of *Vellozia* species



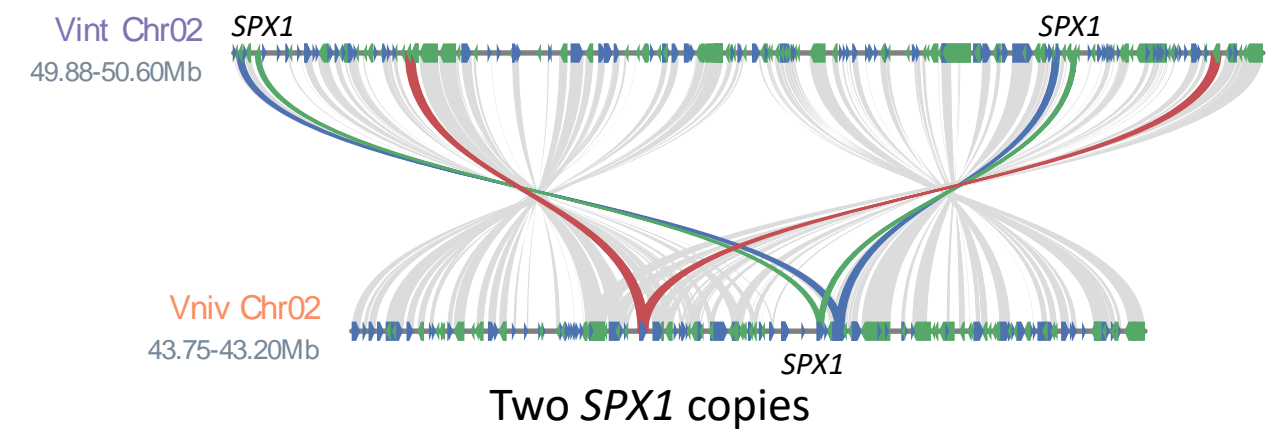
Despite different drought tolerance strategies, the genomes of *V. intermedia* and *V. nivea* are distributed on eight highly syntenic chromosomes with similar gene density profile



Chromosomal level genome assembly



- *V. intermedia* shows an expansion of gene families related to circadian cycle control and solute transport
- *V. nivea* shows an expansion of gene families involved in cell wall modification



Microbiome of *Vellozia* spp. helps understand drought tolerance and phosphorus acquisition



Genome sequencing progress

Year 2000

100 people for one bacterial genome

Year 2021

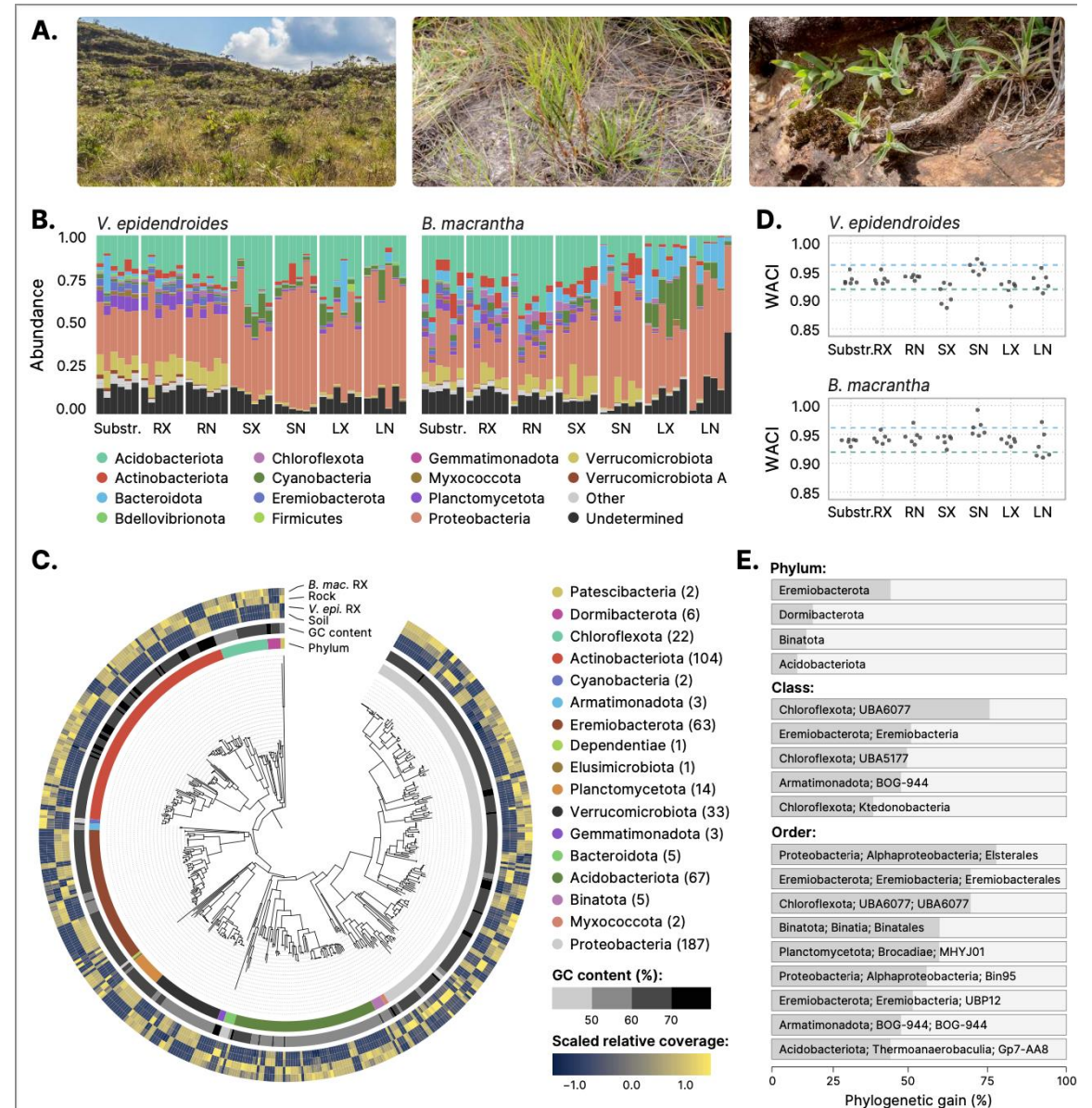
1 Ph.D. student for 500 genomes assembled from environmental DNA shotgun reads

Plant-associated microbiomes promote nutrient turnover in impoverished substrates of a biodiversity hotspot

Antonio P Camargo, Rafael Soares Correa de Souza, Juliana Jose, Isabel R Gerhardt, Ricardo A Dante, Supratim Mukherjee, Marcel Huntemann, Nikos C Kyrpides, Marcelo F Carazzolle, Paulo Arruda

Publication Date: 201/1/1

bioRxiv



Identifying genes for drought tolerance



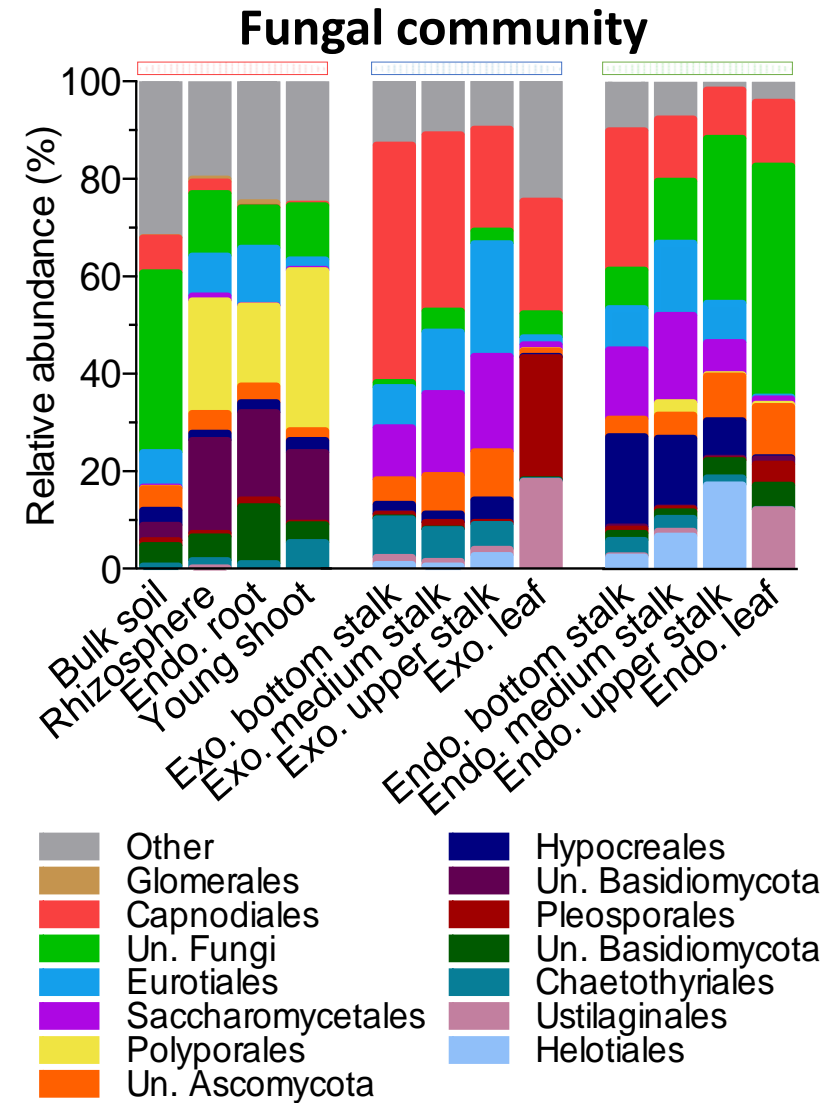
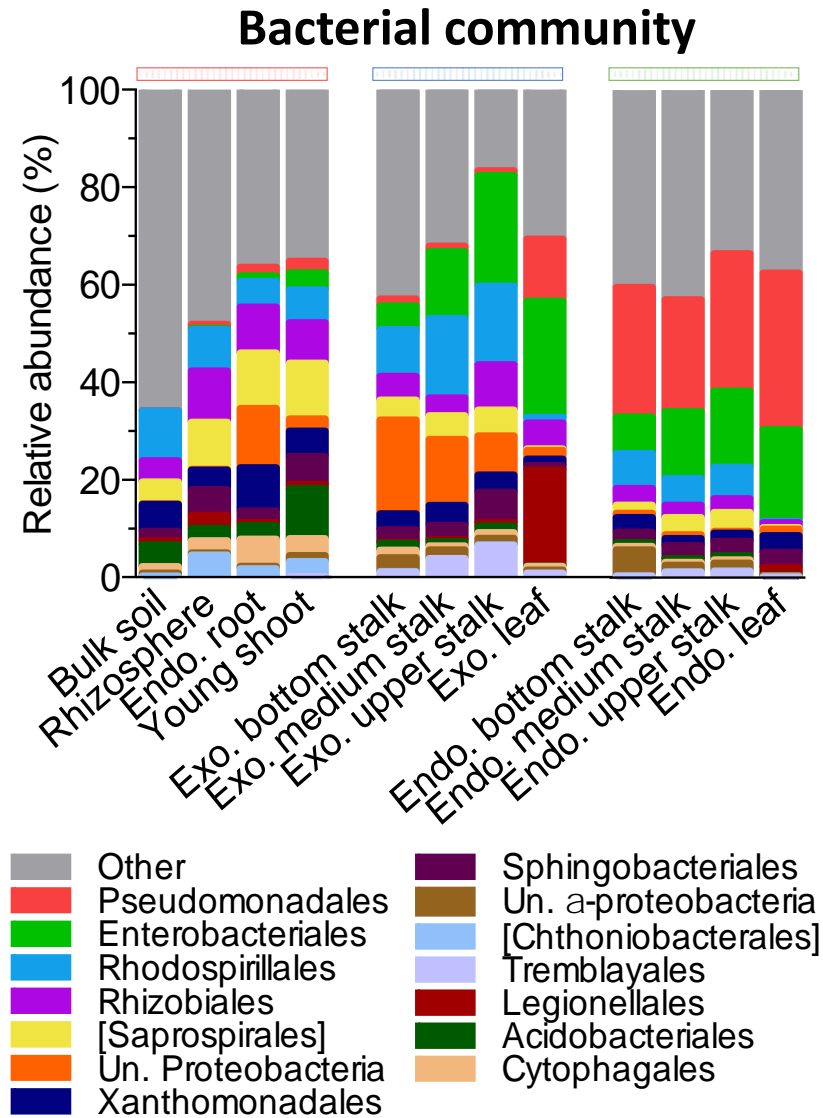
Barley plants 12 days without irrigation

Overexpressing a Ds gene

Control



What about the plant microbiome and the stress response



Synthetic microbial communities make maize plants more tolerant to drought



The PhD student did not find any difference in plant development following inoculation a commercial maize hybrid with a SynCon.

He left the plants in the green house for three weeks without irrigation.

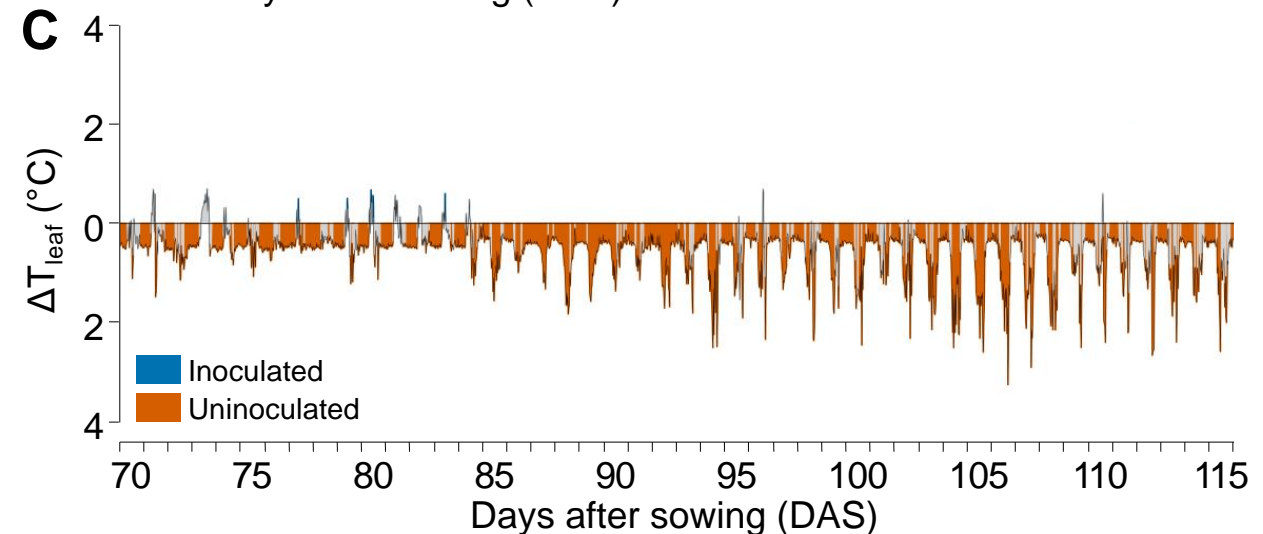
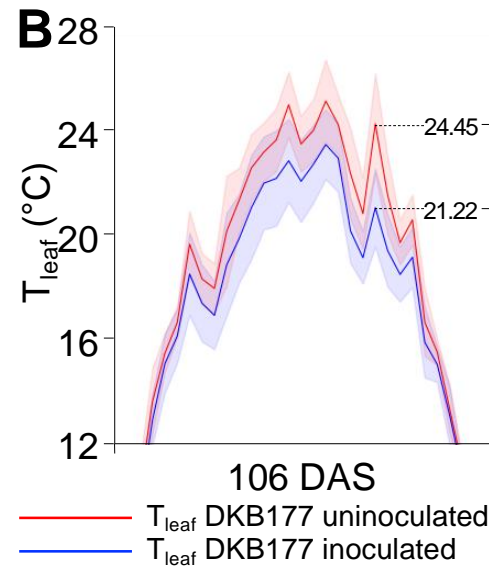
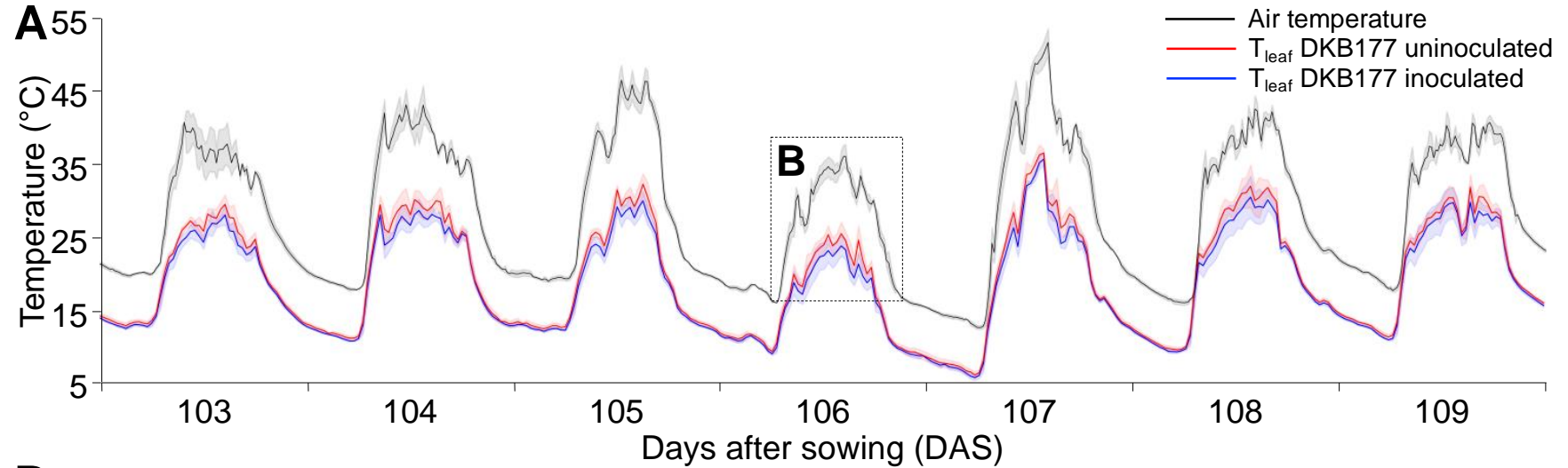
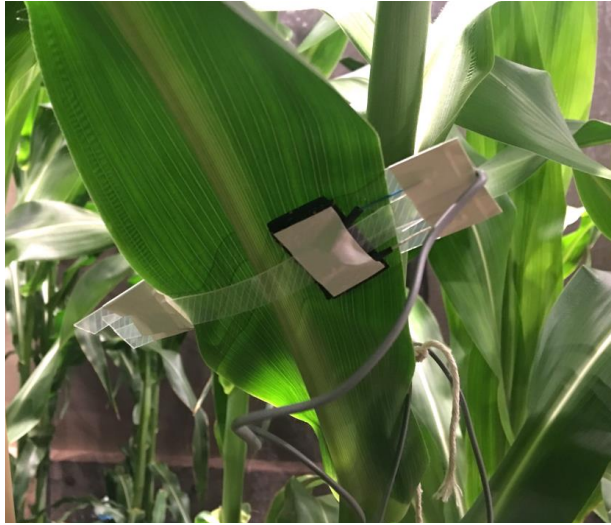
What a big surprise when returning to the green house to discard the experiment



SynCon Inoculated

Non-noculated

The Syncom optimizes leaf temperature control



The SynCom optimizes plant temperature control by reducing T_{leaf} peaks in DKB177 hybrid



The GCCRC Team and Collaborators



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Paula Malloy (Unicamp)

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Geraldo Caçado (Embrapa)
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Márcio José da Silva (Unicamp)
Viviane Cristina da Silva (Unicamp)

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Michel Vincentz (Unicamp)
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Sylvia Souza Embrapa)
Wagner Alexandre Lucena Embrapa)
Wislon Tadeu Lopes Embrapa)



What's next?

Yes, for Unicamp, but not for Science & Innovation

Vesper Ventures

<https://vesper-ventures.com>



<https://inedita.bio>



<https://www.symbiomics.com.br>

Thank you

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