New Insights into the Evolution of *Fusarium* Pathogenesis in Wheat

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CSIRO PLANT INDUSTRY
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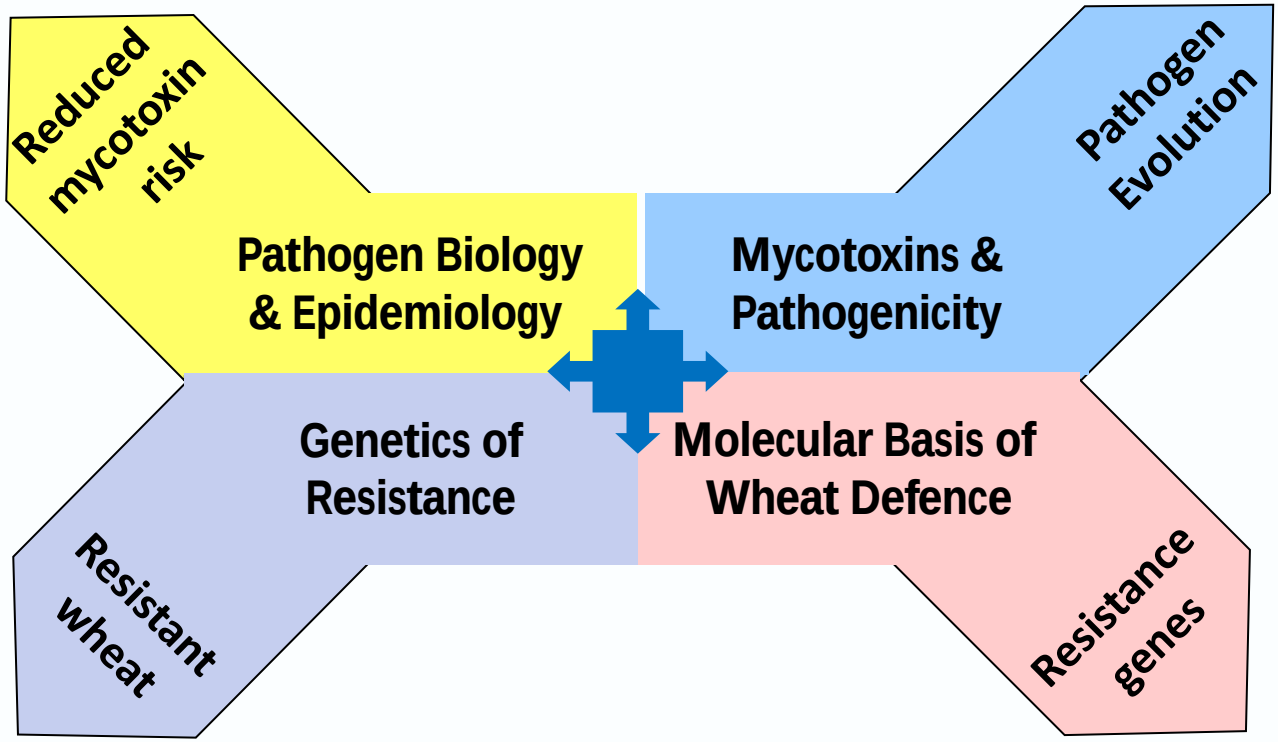
Where are we?

CSIRO Plant Industry, Brisbane

Queensland Bioscience Precinct – BRISBANE

Research Station – GATTON

Wheat - Fusarium Research in CSIRO



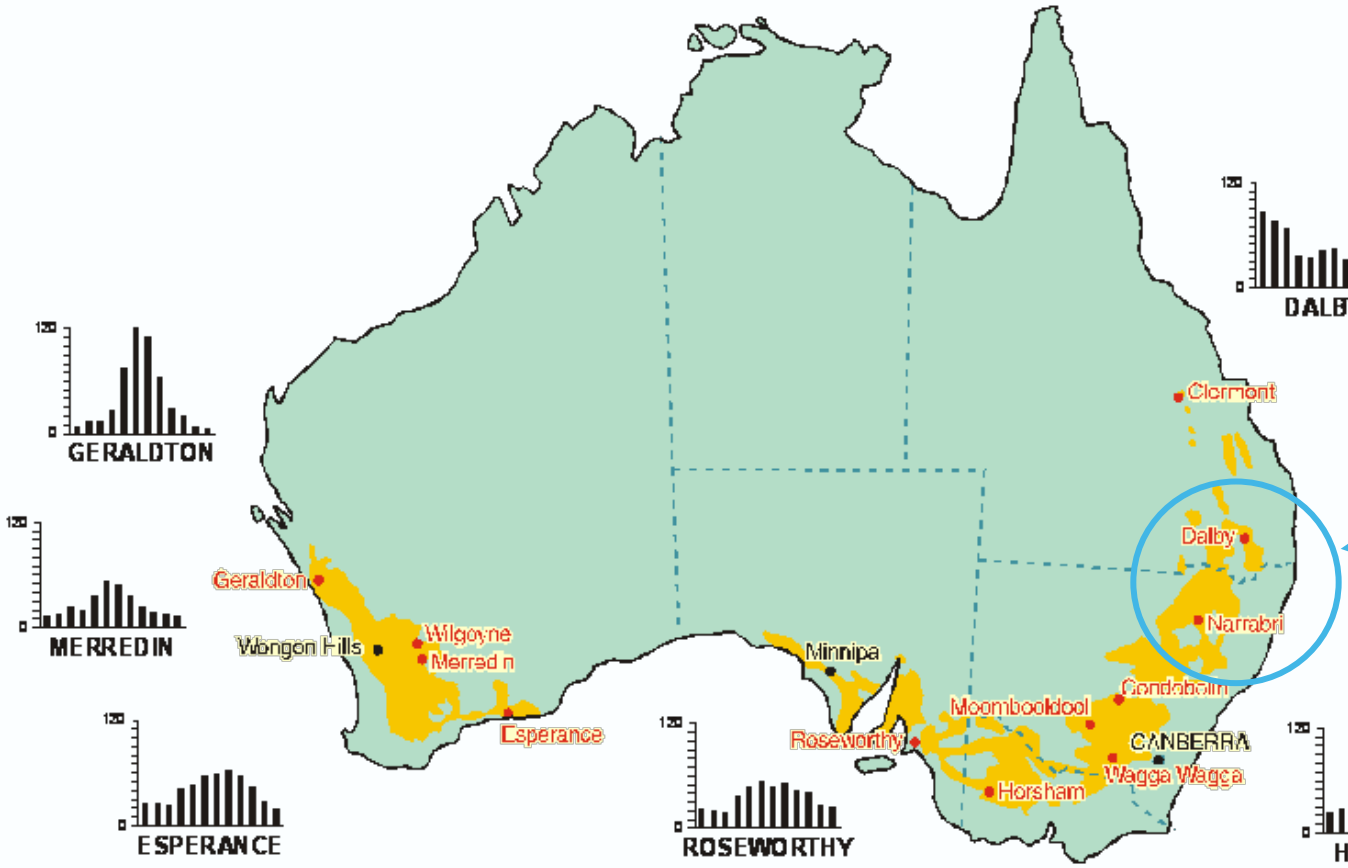
Four inter-connected strands to deliver industry and science outputs

A tale of two diseases

wet finish = head blight - dry finish = crown root

F. pseudograminearum and *F. graminearum* can cause both crown rot and head blight

Australian Wheat Belt & Fusarium



Northern Region

§ Summer rain

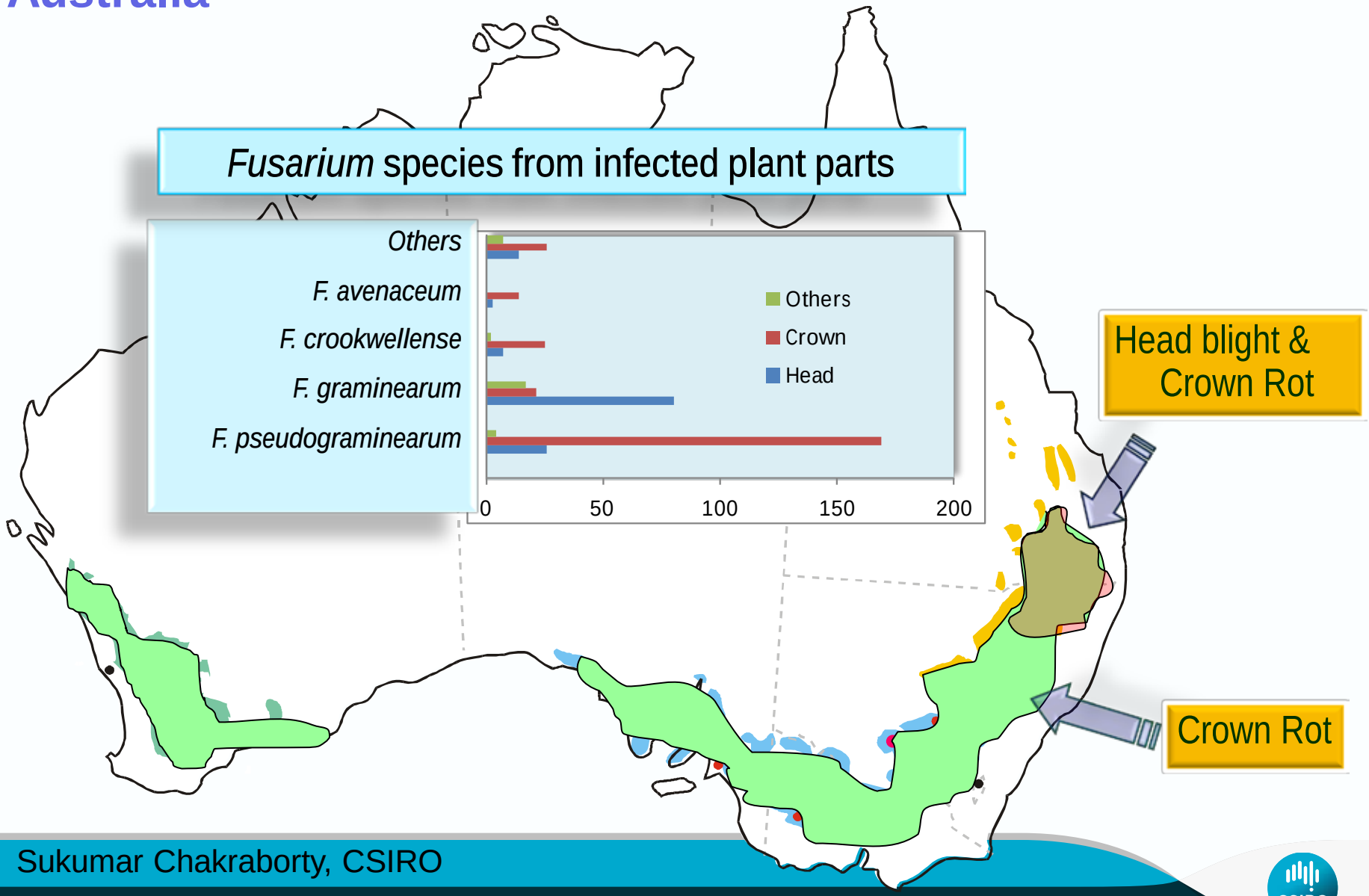
Fusarium Head Blight

Southern and Western Regions

§ Winter rain

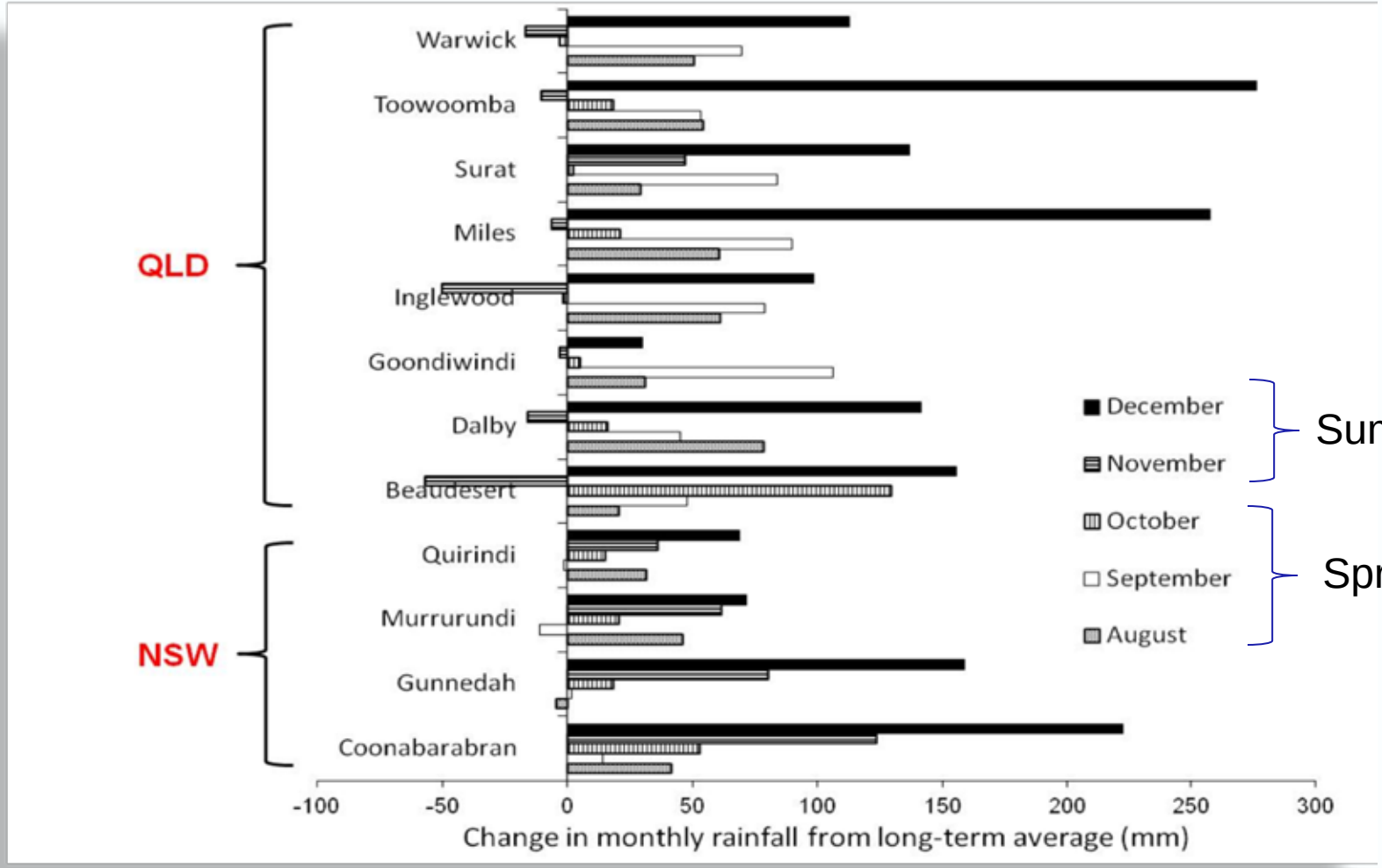
Crown rot found in all regions.
Mainly F. pseudograminearum

Fusarium species causing crown rot and head blight in Australia



Sukumar Chakraborty, CSIRO

2010 wheat season had a very wet finish



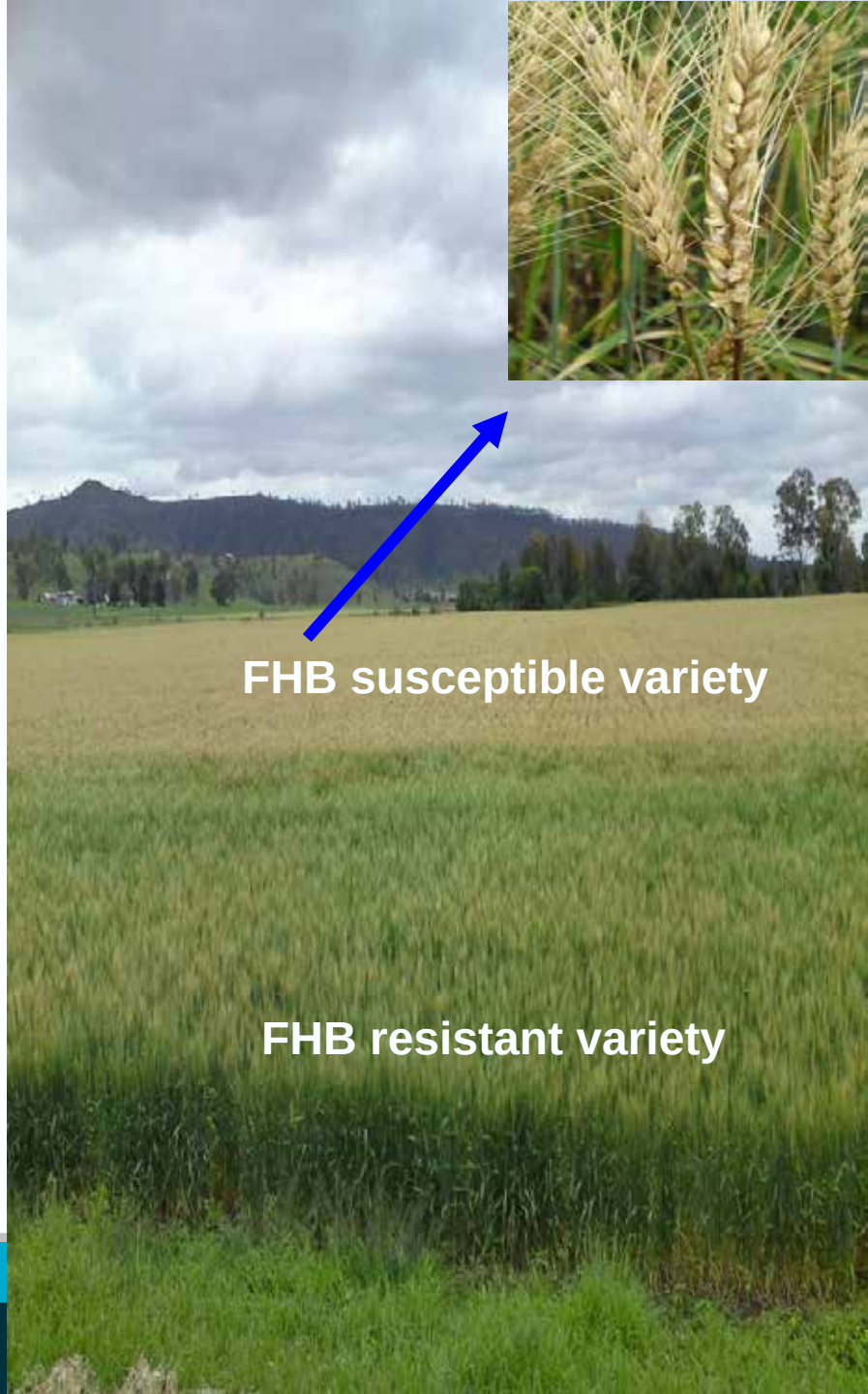
Obanor et al. (2012) Plant Pathology

FHB epidemic 2010

Wheat crops were sampled from 25 sites in QLD and 19 in NSW at soft dough or early maturity stage

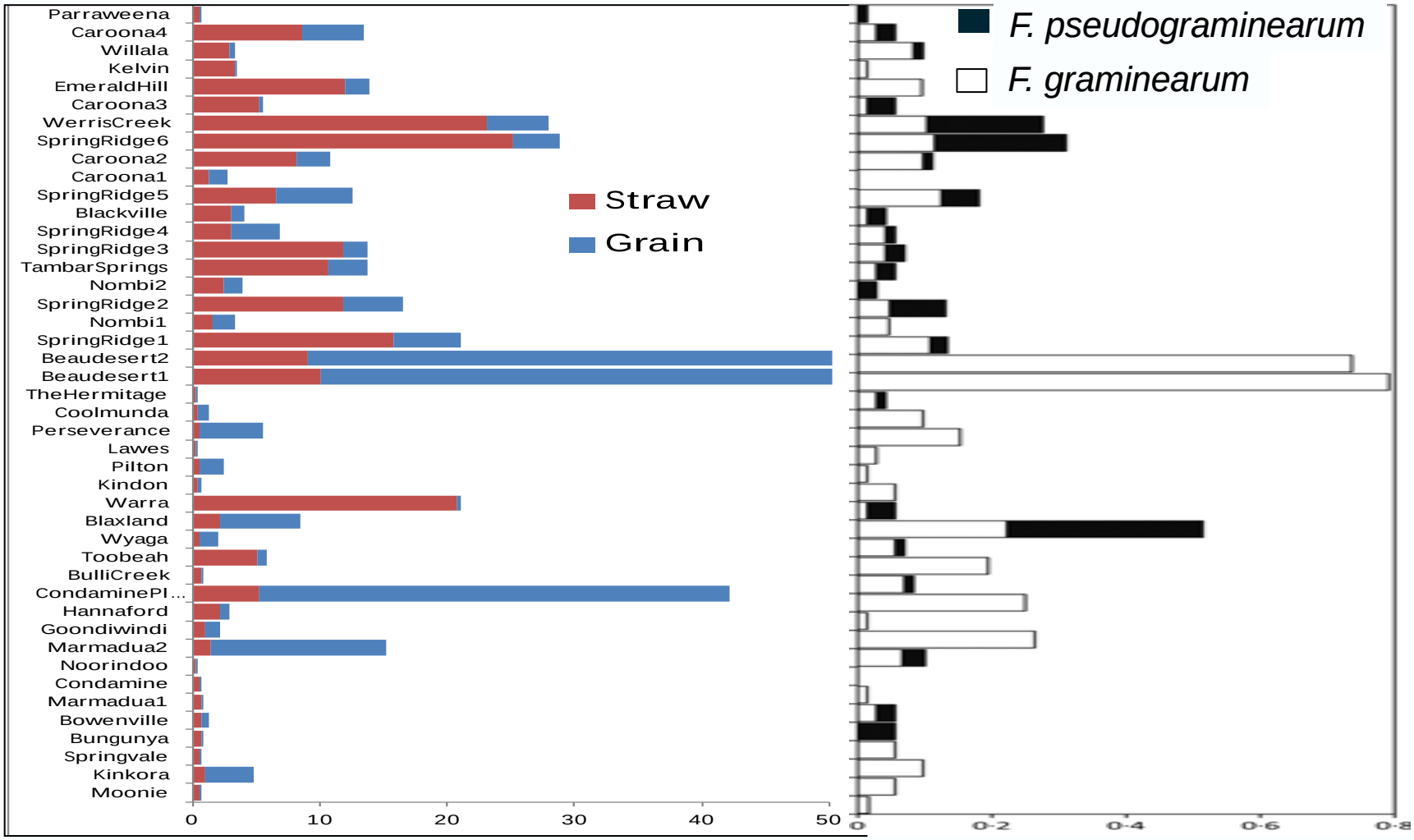
FHB was widespread on bread wheat and durum

Both *Fusarium graminearum* and *F. pseudograminearum* caused FHB epidemic



Obanor et al. (2012). Plant Pathology

FHB epidemic 2010



DON concentration (mg/kg)

Proportion of spikelets

Obanor et al. (2012). Plant Pathology

What happened to the big wet after December 2010?

St Lucia (University of Queensland)

December 2010

January 2011


DYO960

Major Questions

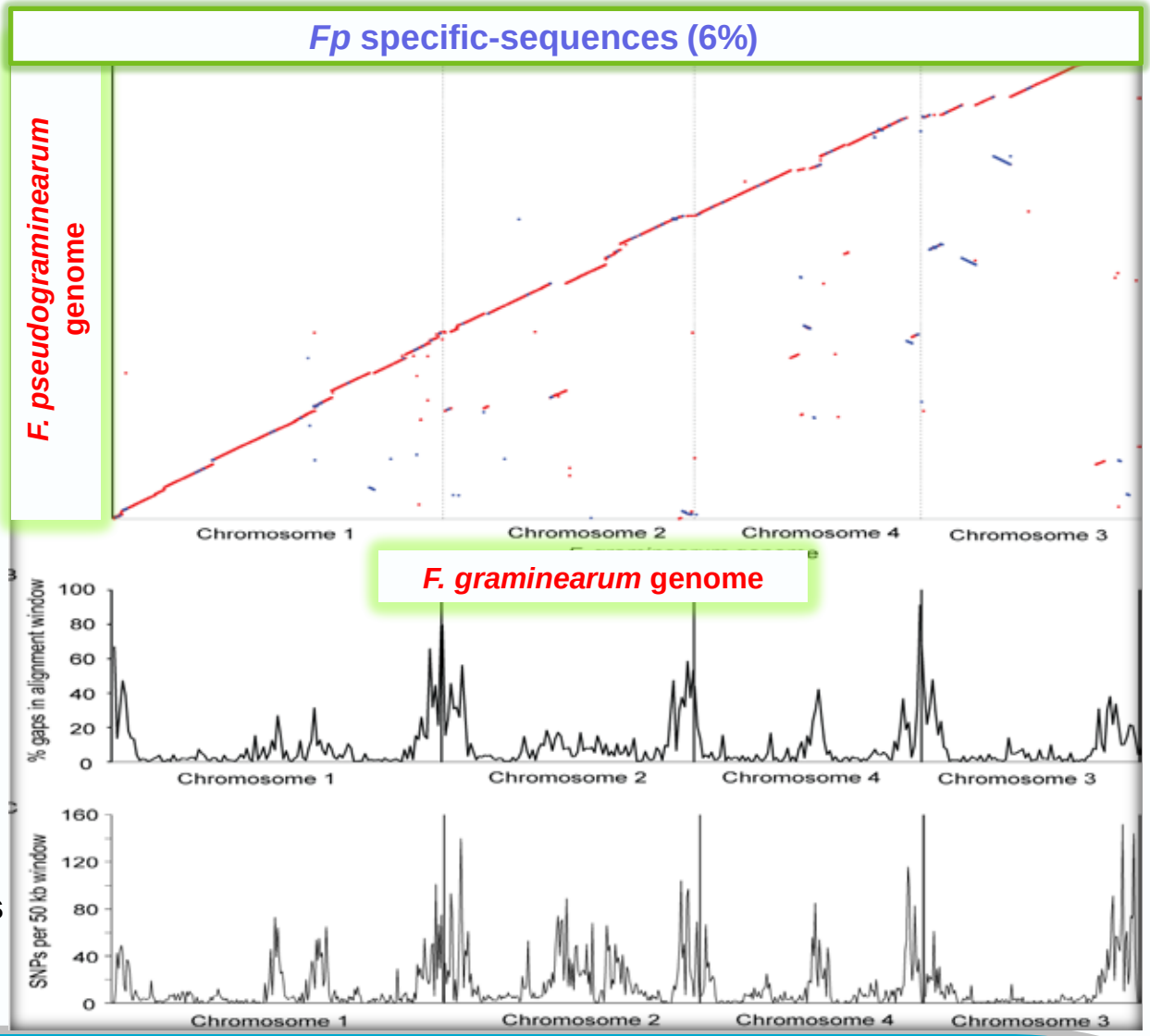
- Why is *F. pseudograminearum* predominant in crown rot?
- Why is *F. pseudograminearum* so broadly adapted?
- What cereal defences are overcome by *F. pseudograminearum* and how?

F. pseudograminearum genome

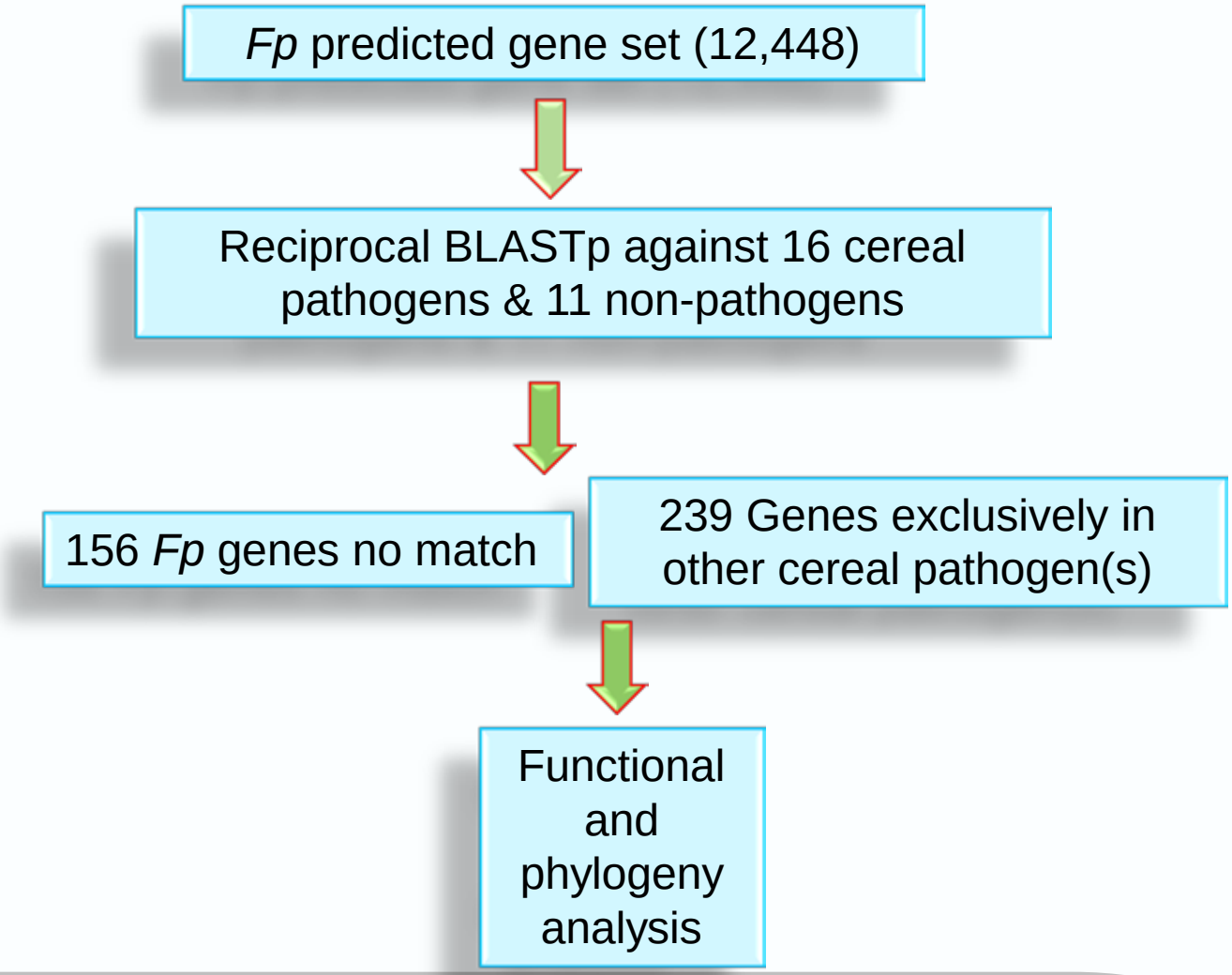
Species	Size	Technology	Coverage
F. pseudograminearum	*37Mbp*	*Illumina*	*179x*
F. graminearum[1]	*36Mbp*	*Sanger*	*10x*
F. oxysporum f. sp. lycopersici [2]	*60Mbp*	*Sanger*	*6x*
F. oxysporum 5176 [2,3]	*55Mbp*	*454*	*8x*
F. verticillioides [2]	*41Mbp*	*Sanger*	*8x*

[1] Cuomo et al 2007; [2] Ma et al 2010; [3] Thatcher et al 2012; Gardiner et al 2012

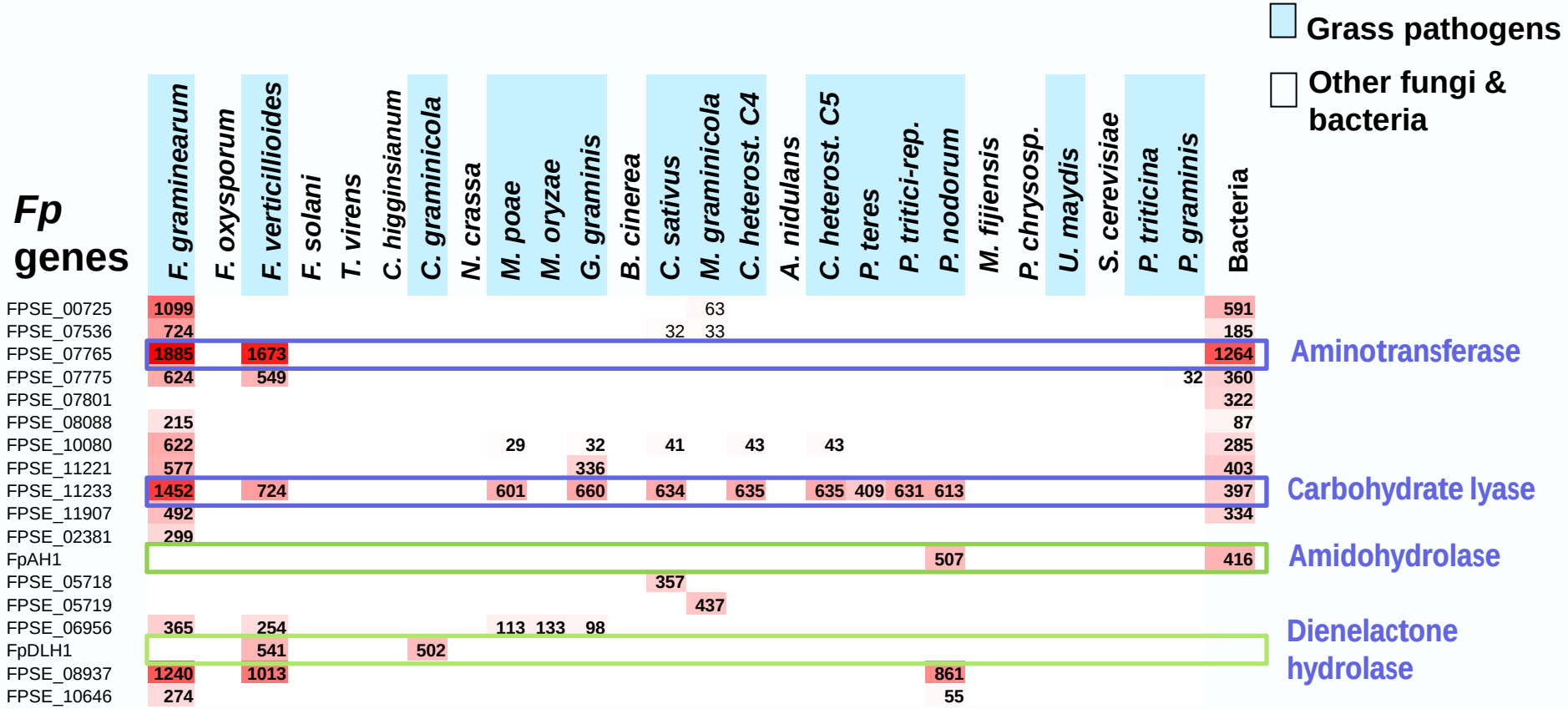
Comparison of *F. pseudograminearum* & *F. graminearum* genomes



Comparative genomics pipeline



Examples of F. pseudograminearum genes exclusively shared by cereal pathogens with some acquired from bacteria



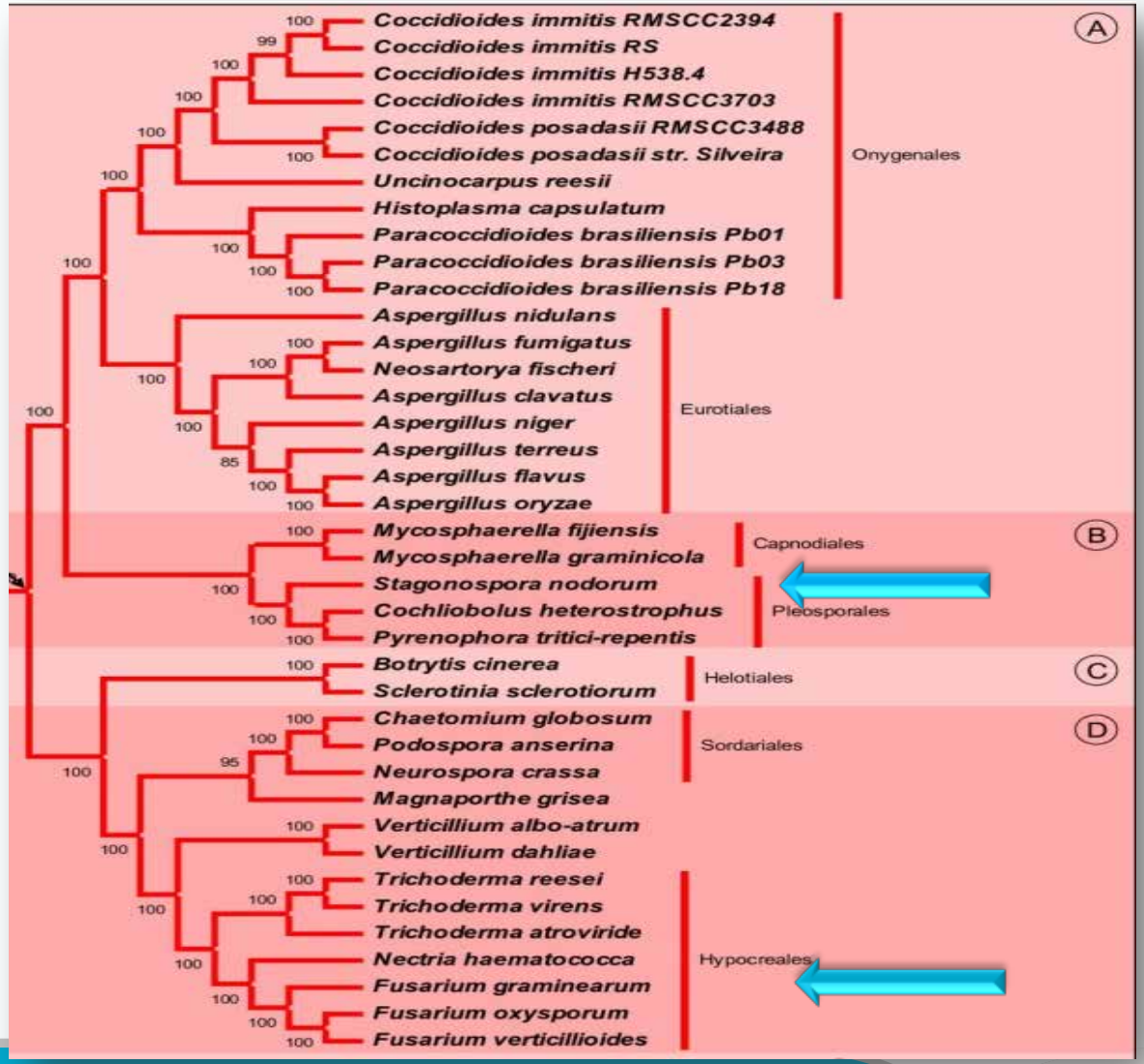
Numbers indicate BLAST bit score

Where did FpAH1 come from?

Genetic exchange between *Stagonospora* and *Fp?*

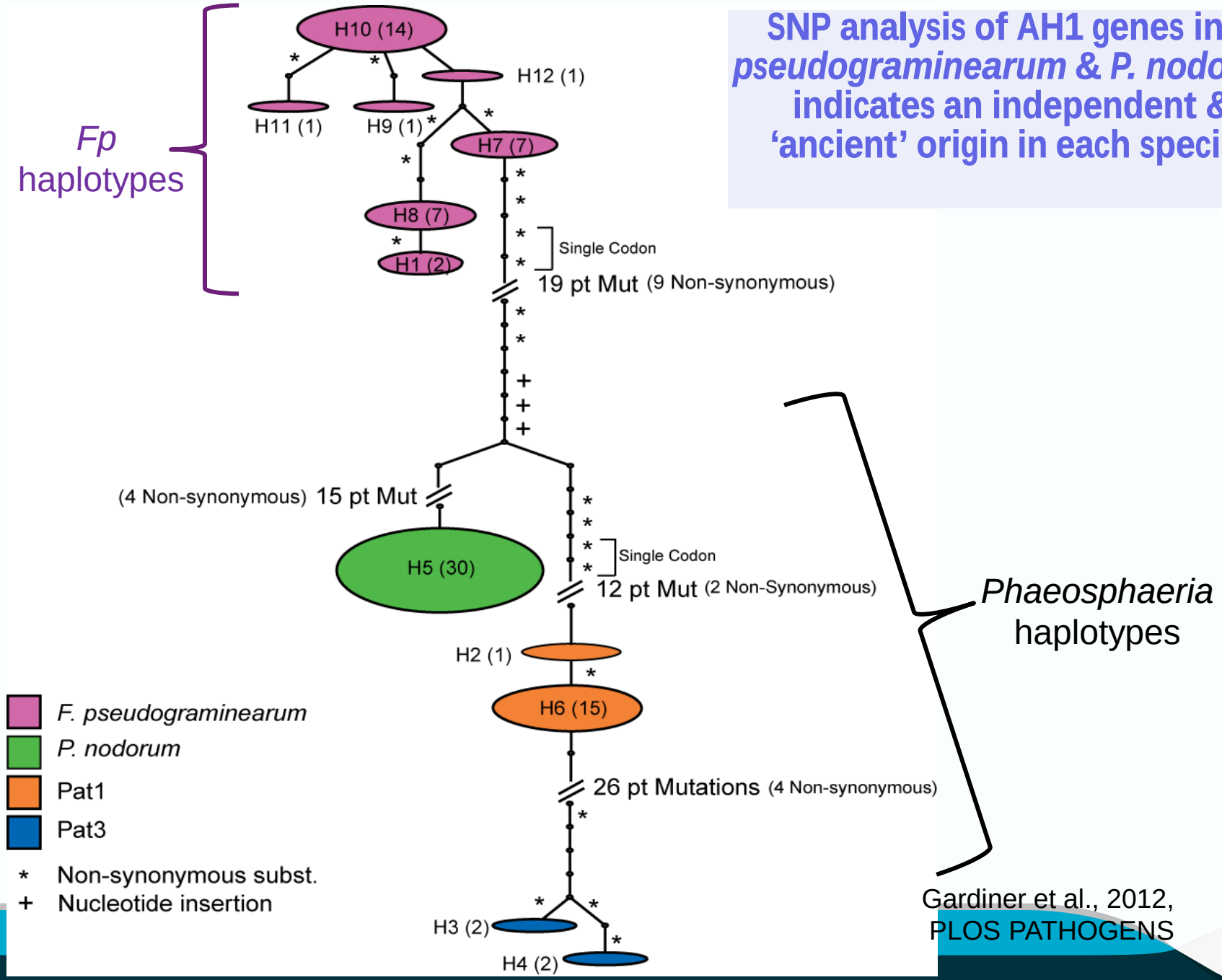
or

Independent acquisition from bacteria?



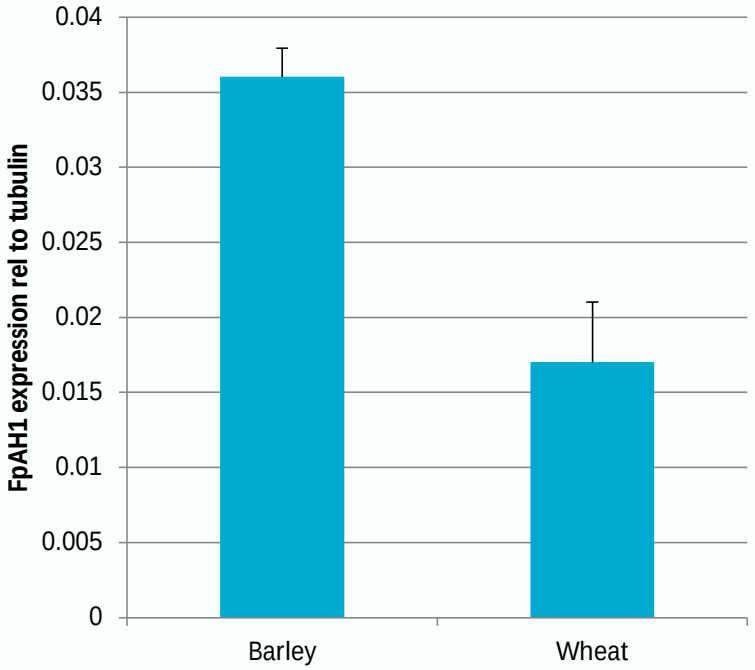
Wang et al BMC Evol Biol 2009, **9**:195

SNP analysis of AH1 genes in *F. pseudograminearum* & *P. nodorum* indicates an independent & 'ancient' origin in each species



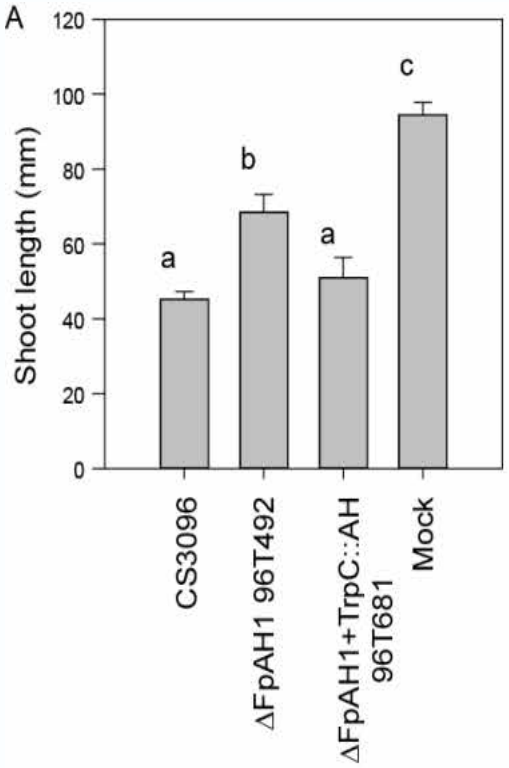
Gardiner et al., 2012, PLOS PATHOGENS

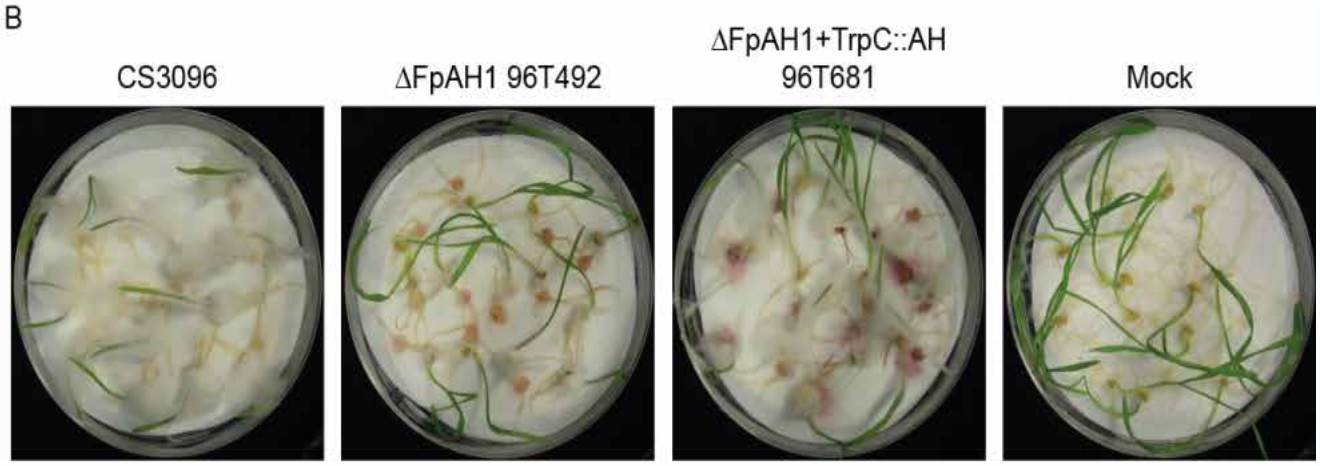
FpAH1 is expressed during crown infection



FpAH1 promoter-GFP fusion
and Real-time RT-PCR

FpAH1 is important for full virulence on wheat





Wild type inoculated

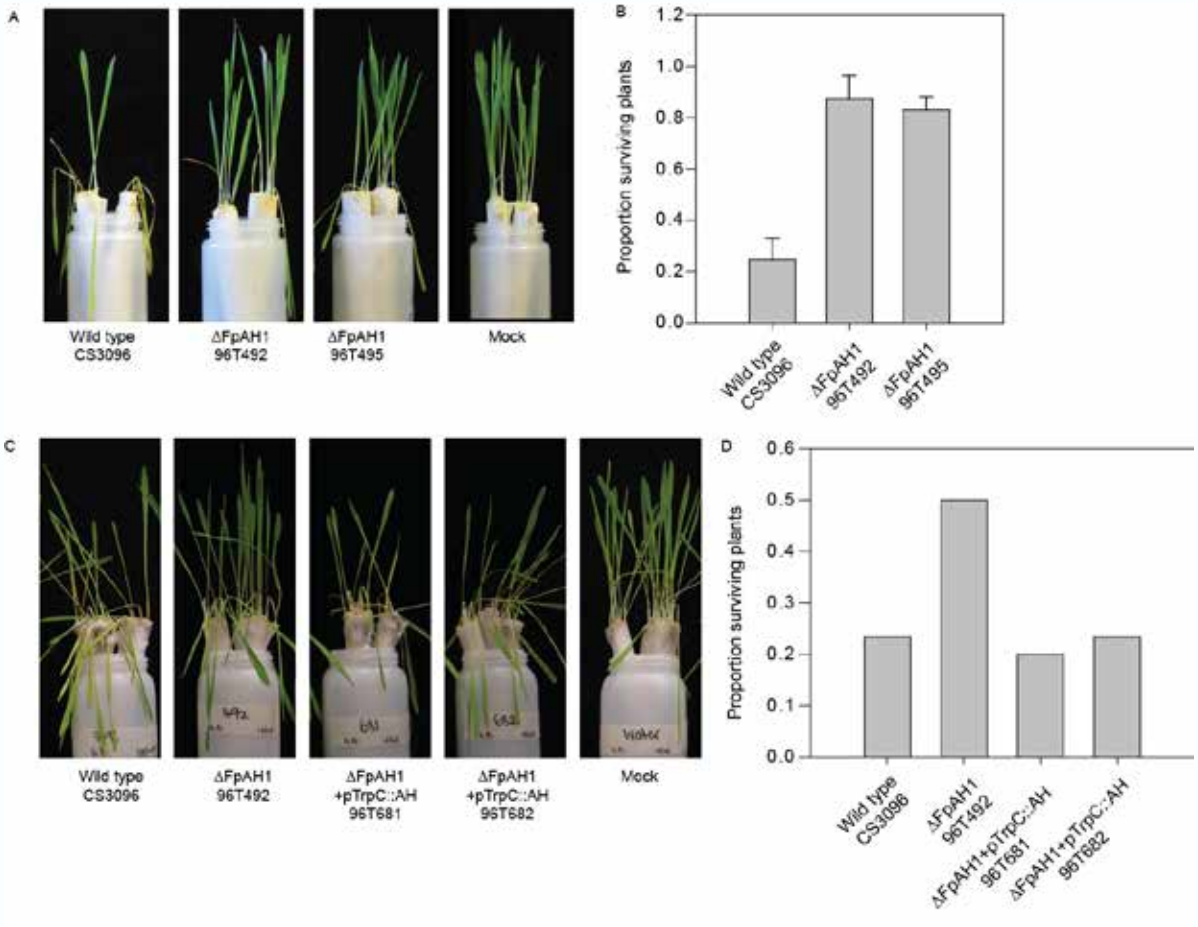
mutant

Complemented mutant

Wild type mock

Gardiner et al., 2012, PLOS PATHOGENS

FpAH1 is required for full virulence on barley



FpAH1 knockouts have reduced virulence (i.e. increased plant survival)

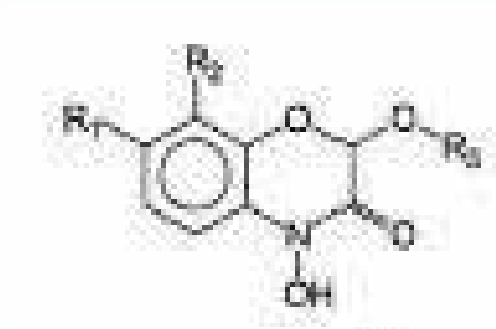
FpAH1 complementation restores virulence in knock outs

Gardiner et al., 2012, PLOS PATHOGENS

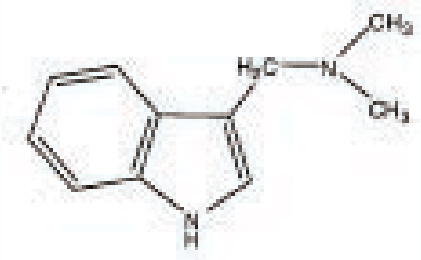
What is the mode of action of FpAH1?

Amidohydrolases are a diverse superfamily of enzymes which catalyse the hydrolysis of amide bonds in a large number of different substrates

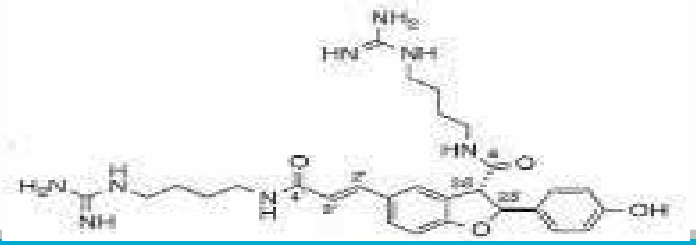
Amide-containing cereal defence molecules



Hydroxamic acids (DIMBOA)



Gramine (indole alkaloid)



Hordatine

Evolution of pathogenicity in cereal pathogens: possible roles for horizontal gene transfer

Stagonospora nodorum

ToxA gene

Pyrenophora tritici-repentis

Plant endophytic bacteria

Amidohydrolase

Fusarium pseudograminearum

Dienelactone hydrolase + Amidase

Colletotrichum graminicola

Fusarium verticillioides

Genomes now under comparative analysis

Species	Isolate	Interest
F. pseudograminearum	CS3220	Moderate pathogenicity
	CS3427	High pathogenicity
	CS3487	Promiscuous mating isolate
	CS5834	WA isolate
F. acuminatum	CS5907	CR pathogen occasionally isolated in field
F. equiseti	CS3069	CR pathogen occasionally isolated in field
F. culmorum	CS7071	Globally important species for FCR and FHB

Thank you

CSIRO Plant Industry Brisbane

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