The impact of global change on the emergence of plant diseases and pests in Europe

International conference

23&24

APRIL 2018

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Emergence of wheat blast in India and Bangladesh: an increasing risk for Europe?

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The impact of global change on the emergence of plant diseases and pests in Europe

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Blast is a model for fungal diseases of cereals…

Magnaporthe oryzae = *Pyricularia oryzae*

Molecular Plant Pathology

MOLECULAR PLANT PATHOLOGY DOI: 10.1111/j.1364-3703.2011.00783.x

Review

The Top 10 fungal pathogens in molecular plant pathology

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SUMMARY

The aim of this review was to survey all fungal pathologists with an association with the journal *Molecular Plant Pathology* and ask them to nominate which fungal pathogens they would place in a 'Top 10' based on scientific/economic importance. The survey generated 495 votes from the international community, and resulted in the generation of a Top 10 fungal plant pathogen list for *Molecular Plant Pathology*. The Top 10 list includes, in rank order, (1) *Magnaporthe oryzae*; (2) *Botrytis cinerea*; (3) *Puccinia* spp.; (4) *Fusarium graminearum*; (5) *Fusarium oxysporum*; (6) *Blumeria graminis*; (7) *Mycosphaerella graminicola*; (8) *Colletotrichum* spp.; (9) *Ustilago maydis*; (10) *Melampsora lini*, with honourable men-

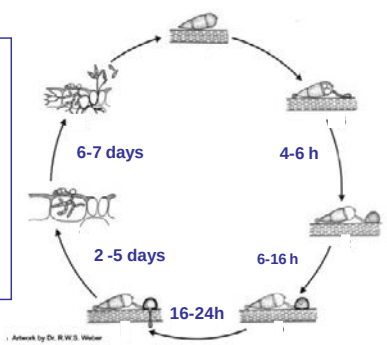
Rice Blast as a Model System for Plant Pathology

Barbara Valent

Magnaporthe **infection : pathogenicity mutants**

Invasion

Signaling
PMK1, MAP kinase
CDC42, GTPase
Cell wall degradation
xylanases
Detoxication
ABC1, efflux pump
Sugars catabolism
NTH1, trehalase
Amino-acids biosynthesis
PTH3, histidine
ILV5, leucine, valine
MET, methionine
Unknown function
MIR1
Non recognition
SSD1, cell wall repair



Appressorium differentiation

Surface sensing
MPG1, hydrophobin,
PTH11, membrane protein
CBP1, chitin binding
cAMP pathway
MAC1, adenylate cyclase
Gα and Gβ sub-units
PMK1 pathway
PMK1/MST7/11, MAP kinases
GTPases
RHO3
Calcium pathway
Caldmodulin,calcineurin
Cell cycle
NIMA
Enzymes
CUT2, cutinase
Unknown
PTH12, transcription factor
CON7, transcription factor

Penetration

Sugar/lipid
ICL1, isocitrate lyase
PTH2, carnithine acetyl transferase
PTH8 sterol glucosyl transferase
PEX6, peroxisome
MFP1, beta-oxydation
Autophagy
ATG1/8, lipid catabolism, cell death
Melanine biosynthesis
BUF1, ROS1, ALB1, laccase
Sugar/metabolic regulation
TPS1, trehalose synthase

Cell wall signaling pathway
MPS1, MAP kinase
MIG1, transcription factor
Cell wall component
MMT1, metallothionein
HEX1, woronin body
EMP1, extracellular matrix
Transport
ABC3, efflux pump
Protein secretion
APT2, vesicle based secretion
Membranes turnover
PDE1, ATPase

cAMP pathway
CPKA and SUM1, cAMP protein kinase
Calcium pathway
CYP1, cyclophilin
Oxydative signaling
NOX1/NOX2, NaDPH oxydases
Unknown signaling pathway
MST12, transcription factor
BIP1, Bzip transcription factor
Unknown function
GAS1/GAS2, gEgh16 homologs
ORP1, orphan
PLS1 tetraspanin

Current Opinion in Plant Biology 2008, 11:367–372

FOOD SECURITY

… and a major disease of rice

NEWS

Armed and Dangerous

www.sciencemag.org SCIENCE VOL 327 12 FEBRUARY 2010

RICE BLAST

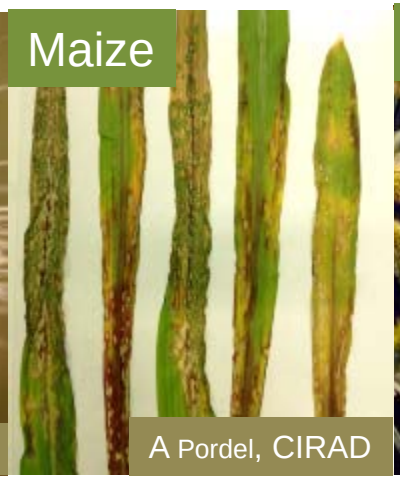
Pest: *Magnaporthe oryzae*
Crops: Rice, 50 species of grasses and sedges
Whereabouts: Worldwide
Symptoms: Spores infect plants, particularly when humidity is high, often killing young plants. In older plants, the fungus can spread and prevent seed formation.
Losses: Destruction can be extremely fast but variable, with up to 100% loss in some paddies. Some analysts estimate that each year blast destroys harvests that could feed 60 million people, at a cost of some $66 billion.
Countermeasures: Rice blast is a formidable foe, persisting despite the best control efforts. Farmers can manage the disease by rotating crops, maintaining water levels (too little water promotes infection), and using fertilizers prudently. Resistant cultivars help, but no cultivar can withstand all races of the fungus, and blast tends to overcome resistance in two or three growing seasons. Farmers can also use fungicides.

CREDITS (TOP TO BOTTOM): USDA APHIS PPQ; BUGWOOD.ORG; CHRISTINE STONE/USDA; TA. DONALD GROTH, LSU AGCENTER; BUGWOOD

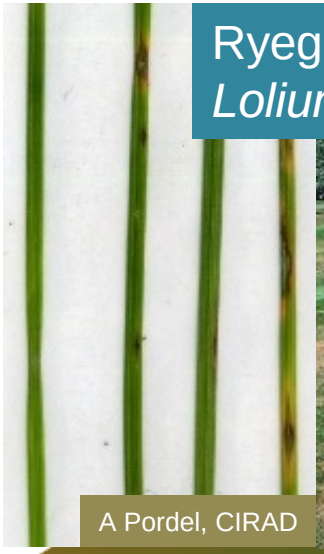
- Worldwide distribution
- 5 M T losses/year (0.8%)
- 2/3 fongicide market on rice
- Localy 100 % losses

Pyricularia oryzae: one pathogen species but many hosts

Food crops

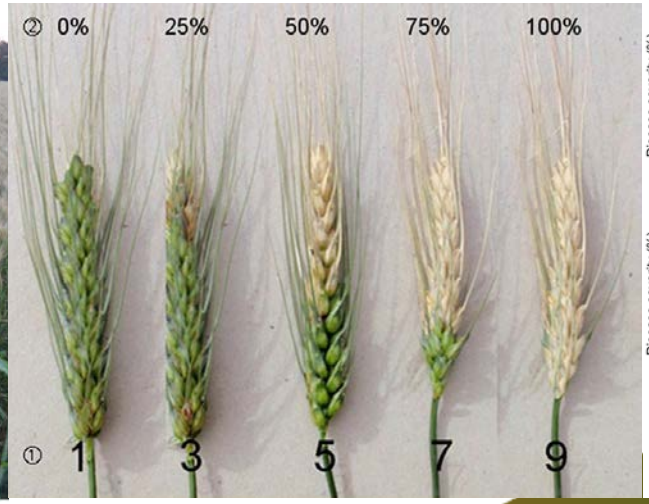


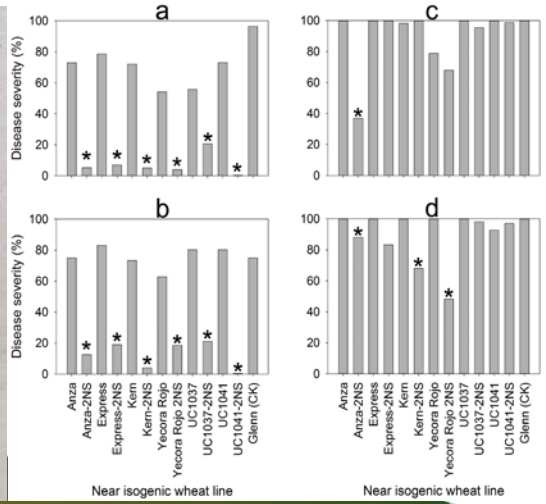
Weeds/lawns



Wheat blast is a devastating disease

- up to 3 M ha affected in Brazil
- high yield losses (100% over hundreds of ha)
- difficult to control
  - low efficiency of fungicides
  - few resistance sources identified

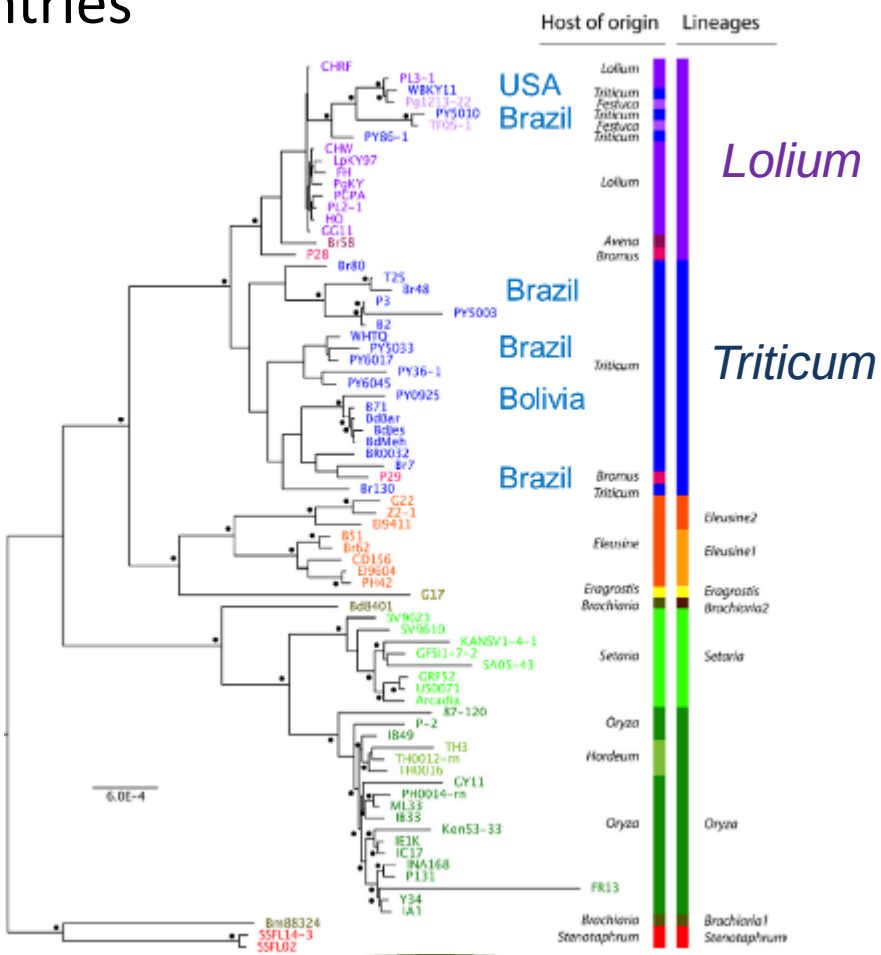




Cruz et al. Crop Sc 56:990 (2016)
Vales et al. Euphytica 214:1 (2018)
Cruz and Valent Trop Pl Pathol 43:210 (2017)

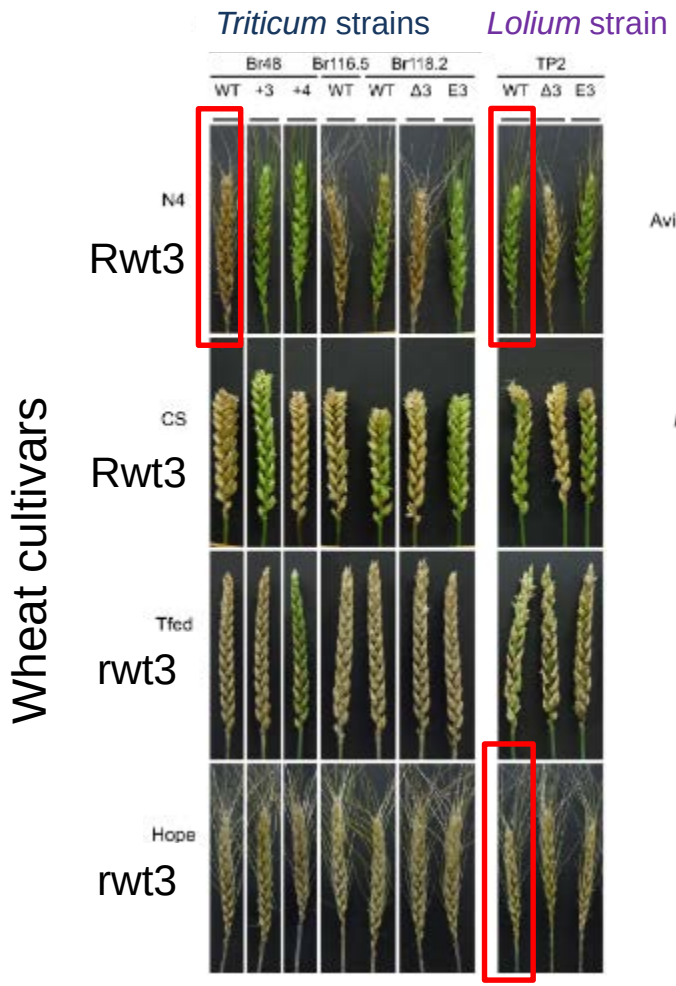
Wheat blast emerged in 1985 in Brazil
and spread to neighboring countries

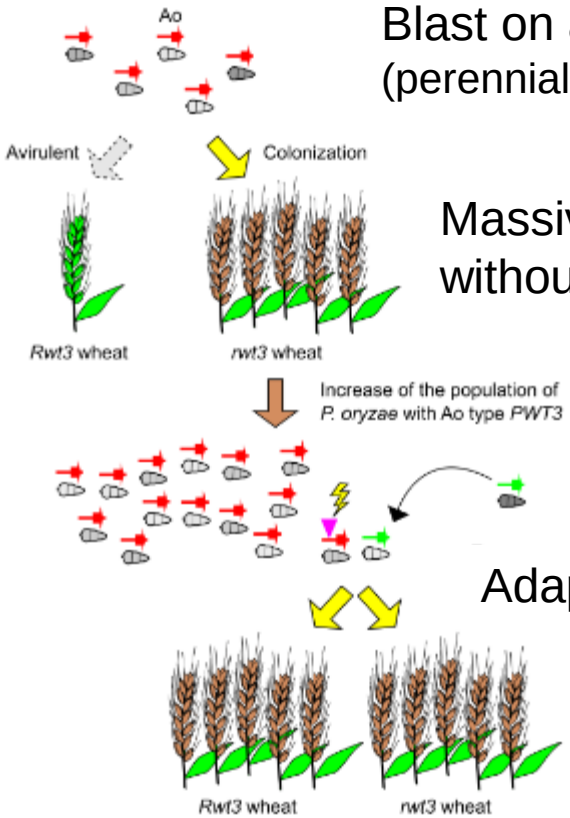
Modified from Cimmyt



Gladieux et al. mBio 9:e01219-17 (2018)

Wheat blast emerged after host jump from a weed
and adapted to wheat resistance





Blast on a weed
(perennial ryegrass = *Lolium perenne*)

Massive cultivation of wheat without Rwt3 R gene in Brazil

Adaptation to Rwt3

Inoue et al. Science 357:80 (2017)

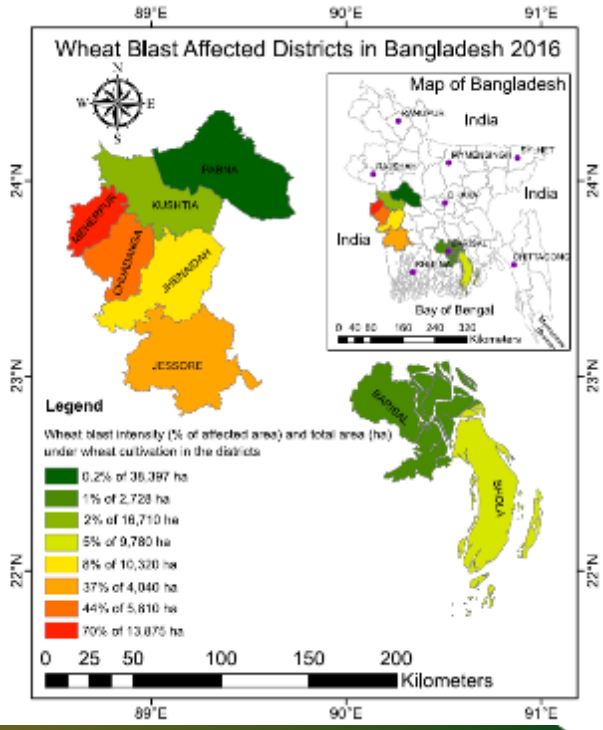
Wheat blast emerged recently in Bangladesh
and spread to India

	2016	2017
Wheat blast	in 8 districts (102 000 ha)	in 11 districts
Fields affected	15%	10-15%
Yield losses	50%	60%

(Wheat in Bangladesh = 498 000 ha)

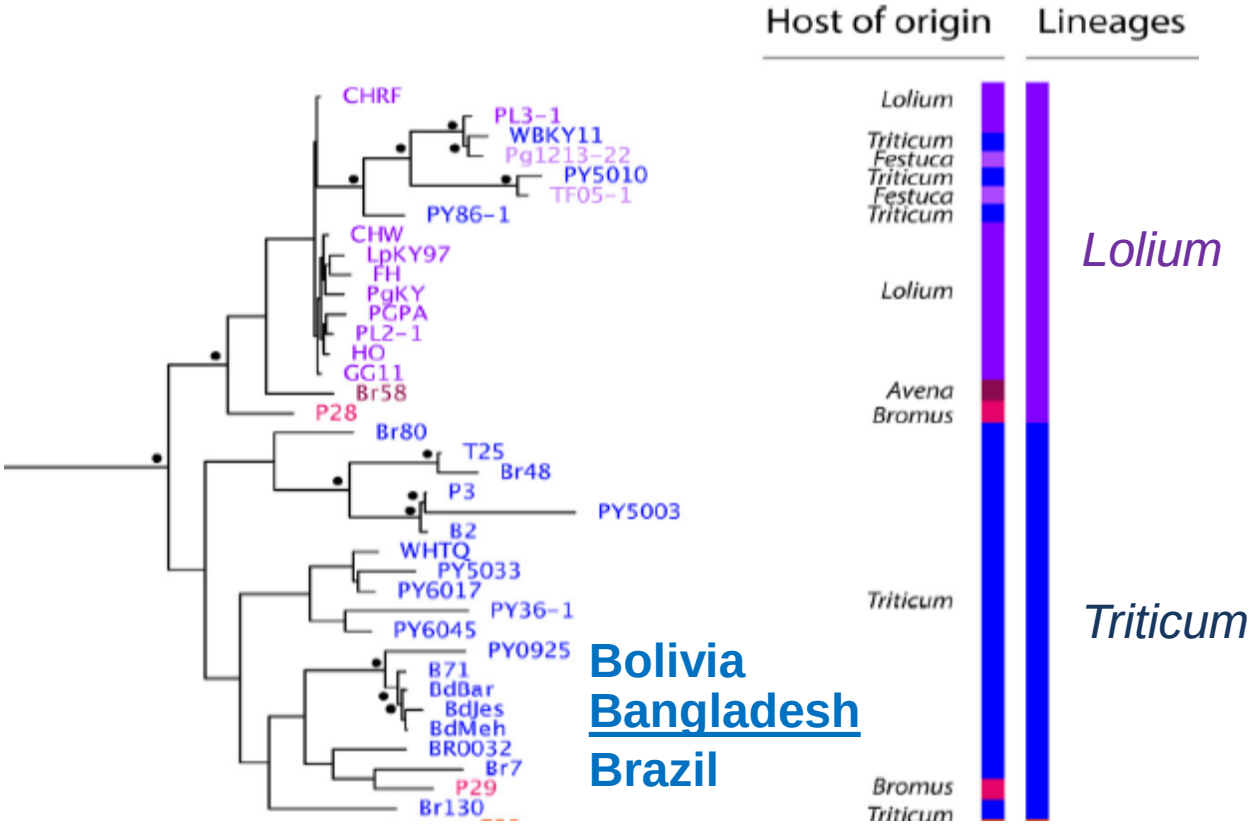
2017

80% reduction of wheat cultivation vs 2016
Report in India



Islam et al. BMC Biology 14:84 (2016)

Wheat blast in Bengladesh originate from South America



Accidental introduction with infected grains

Gladieux et al. mBio mBio 9:e01219-17 (2018)

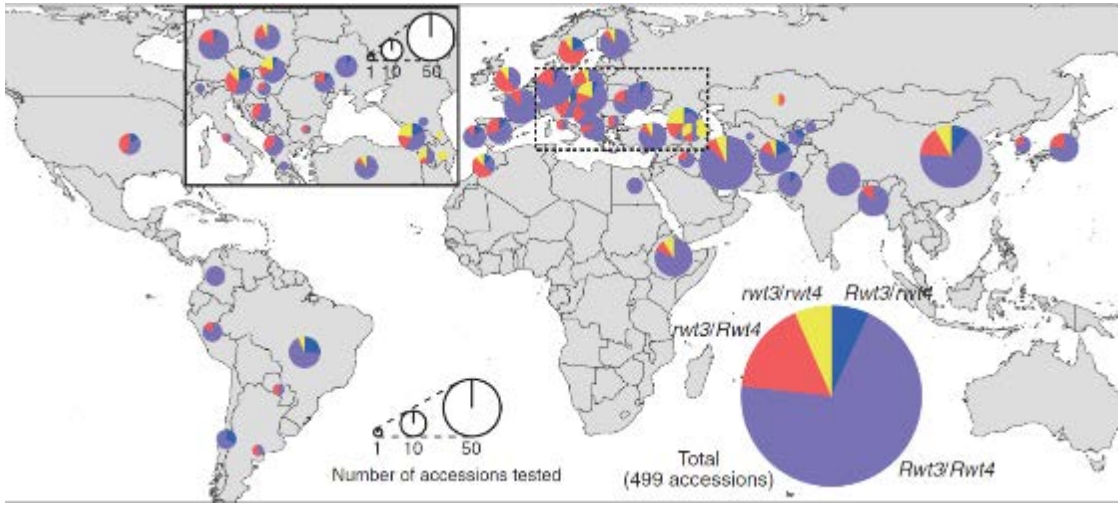
Importance of wheat in Europe:

- 62 M ha planted, 250 M T harvested
- $19.3 billion = 53.3% of global wheat exports

Two types of risks:

- accidental **introduction** through infected seeds

- host jump from ryegrass (*Lolium perenne*)



Inoue et al. Science 357:80 (2017)

Potential source for host jump is present in Europe

P. oryzae causes epidemics on ryegrass

Is *P. oryzae* present on weeds in wheat fields?

There is an urgent need to

1) **inform** about the risks,

2) promote measures to **prevent** the introduction of the pathogen,

3) carry out research work to **measure the risk** (susceptibility of wheat varieties cultivated in Europe, presence of potential sources for host jump…),

4) develop **surveillance** methods and network,

5) set up **eradication plans** to be used if the disease emerges.

Acknowledgements

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Thank you for your attention