Biological control of toxigenic *Fusarium* spp. in crop residues: a new tool for IPM in cereals

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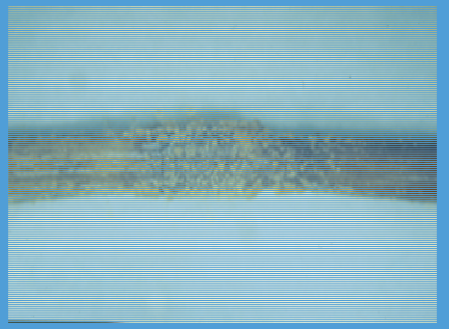
Outline

- Fusarium Head Blight
- Epidemiology and cropping systems
- *Fusarium* spp. on crop residues of wheat
- Selection of antagonists for *Fusarium* control
- Field trials with antagonists
- Conclusions

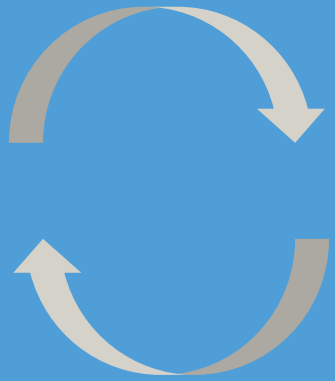


Fusarium Head Blight

- Ear infections of cereals by various *Fusarium* spp.
- Mycotoxin formation by *Fusarium* spp. in grain
- Food safety
- Feed: animal welfare and economics of animal production
- EU Regulation

Epidemiology of Fusarium Head Blight

- Inoculum sources: crop residues
- Infection during flowering
- High risks: rainy weather during flowering and maturation



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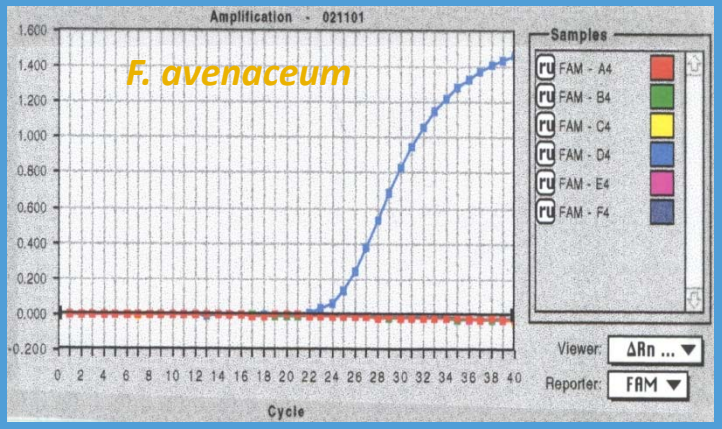
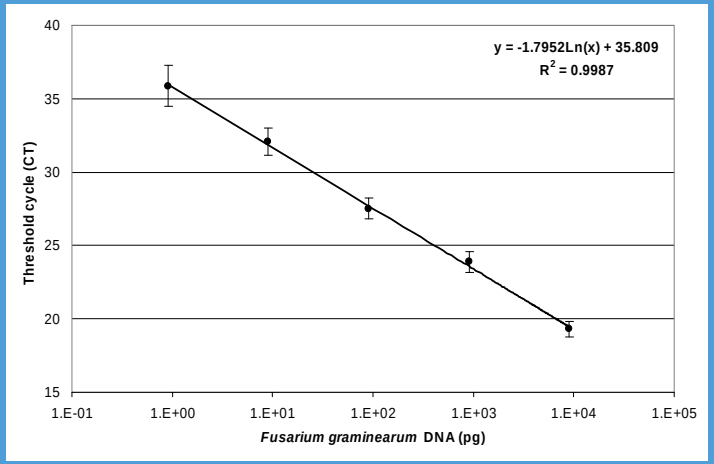
TaqMan real-time PCR

- Sampling
- Homogenisation, Freeze drying
- DNA extraction
- Storage
- Species-specific quantification using species-specific TaqMan probes and primers and internal standards





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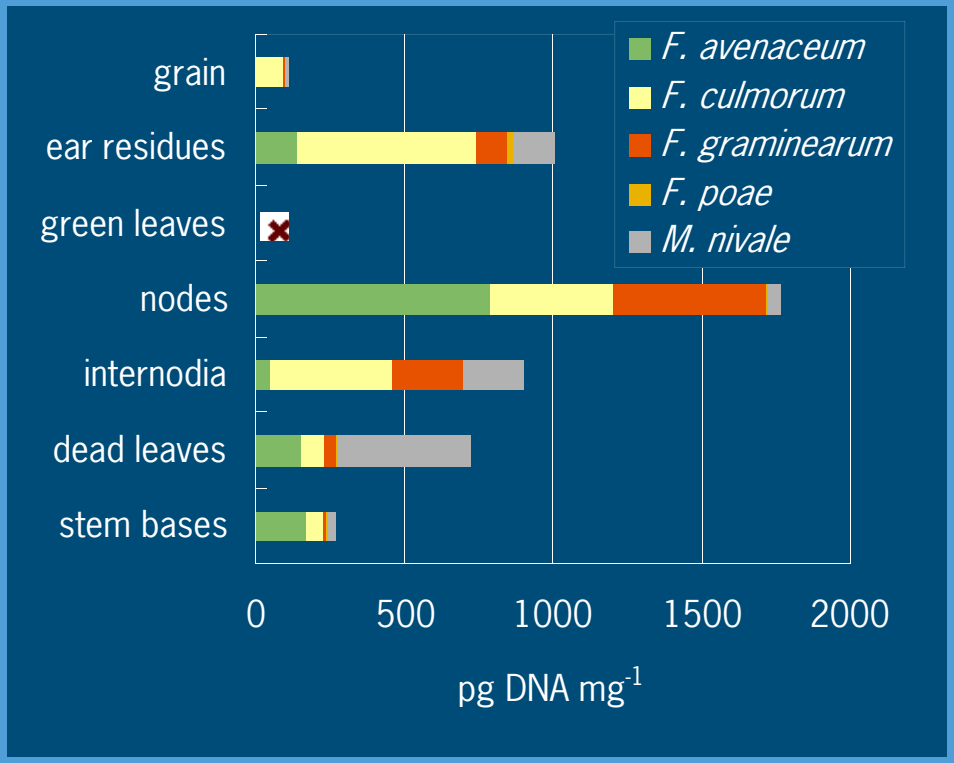
Waalwijk et al., 2004. EJPP 110: 481-494

Colonisation of mature wheat plants by *Fusarium* spp.

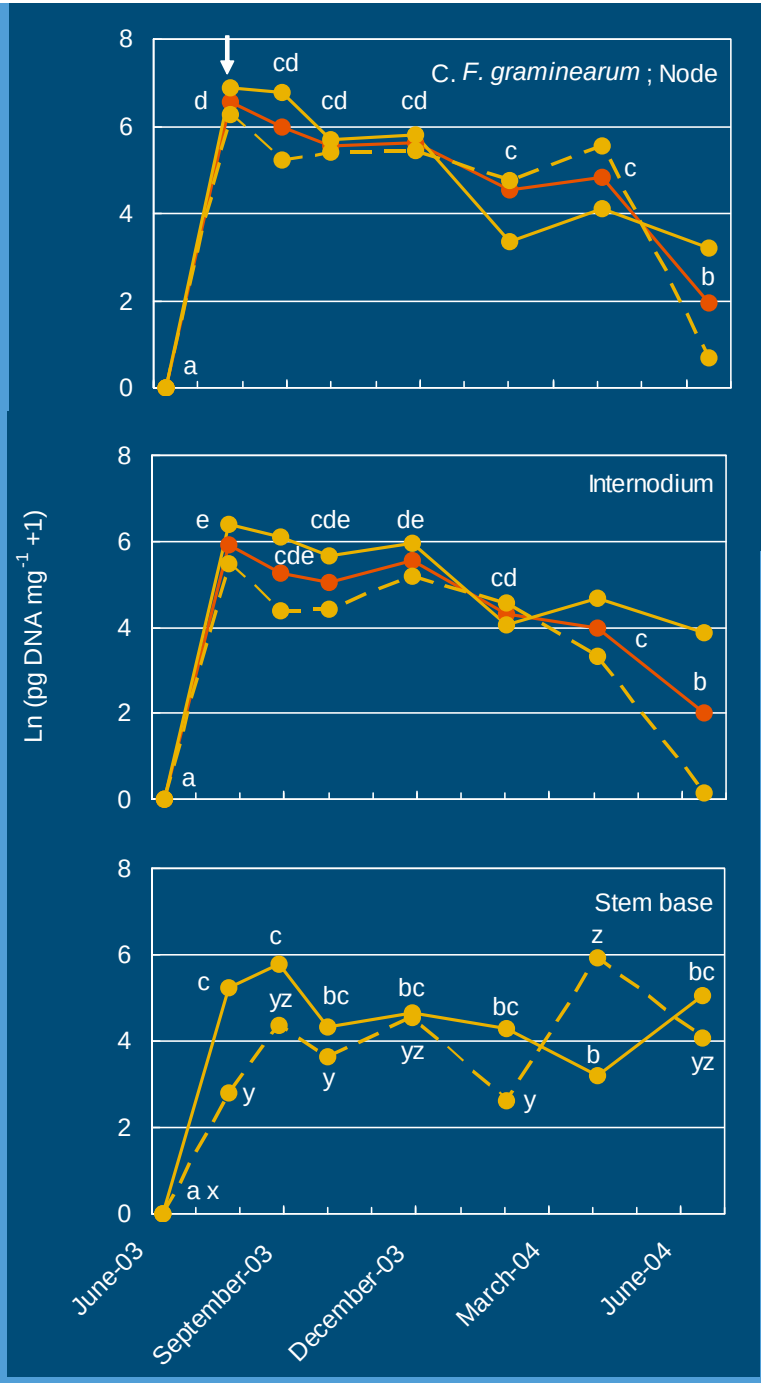


	DON (mg kg^{-1})
Grain	2.2
Ear residues	13
Nodes	16
Internodia	5.2

- *Fusarium*: nodes, internodia, ear residues > stem base, leaves > grain

Population dynamics of *Fusarium* spp. in crop residues on field soil

- Similar pattern for several *Fusarium* spp. at 2 locations
- Peak of populations at harvest
- Significant decrease in crops residues of stems except in stem base:
  - at harvest: From all *F.g.* DNA present in a wheat stem < 1% is in the stem base
  - at flowering of the next crop: From all *F.g.* DNA present in the residues of a wheat stem >99% is present in the stem base
- Stubble more important inoculum source than straw ?



Köhl et al., 2007. Phytopathology 97:971-978

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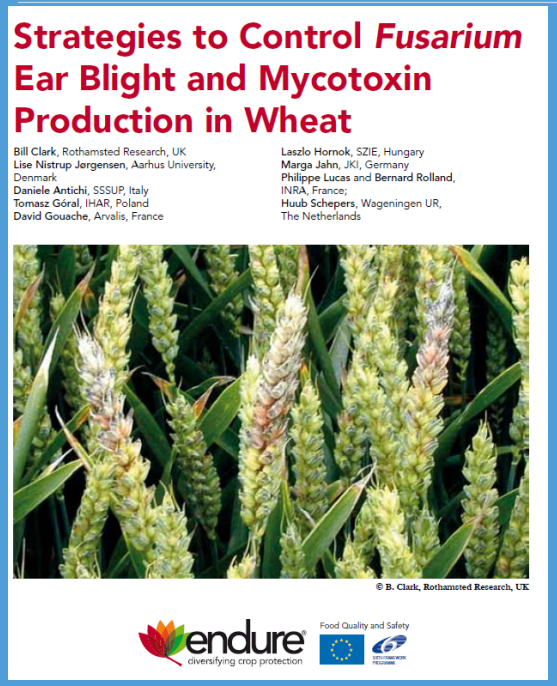
Fusarium Head Blight – Reduced tillage



- Risks particularly high with reduced or minimum tillage
- Application of Good Agricultural Practices can help significantly

Reduced/minimum/no tillage

- Savings of fuel, labour and machinery costs
- Reduced emission of CO_2, N_2O, CH_4 and nutrients
- Less erosion and better use of water
- ➢ IPM tools for use in reduced/no tillage systems
- ➢ Is biological control on crop residues an option?

Antagonist screening: bio-assay

Inoculation

- Sterile stem segments
- *Fusarium* spp.
- Antagonist candidate

Incubation

- Moist chamber
- 15°C
- Blacklight

Assessment

- Counts of *Fusarium* spores

Antagonist screening: Results

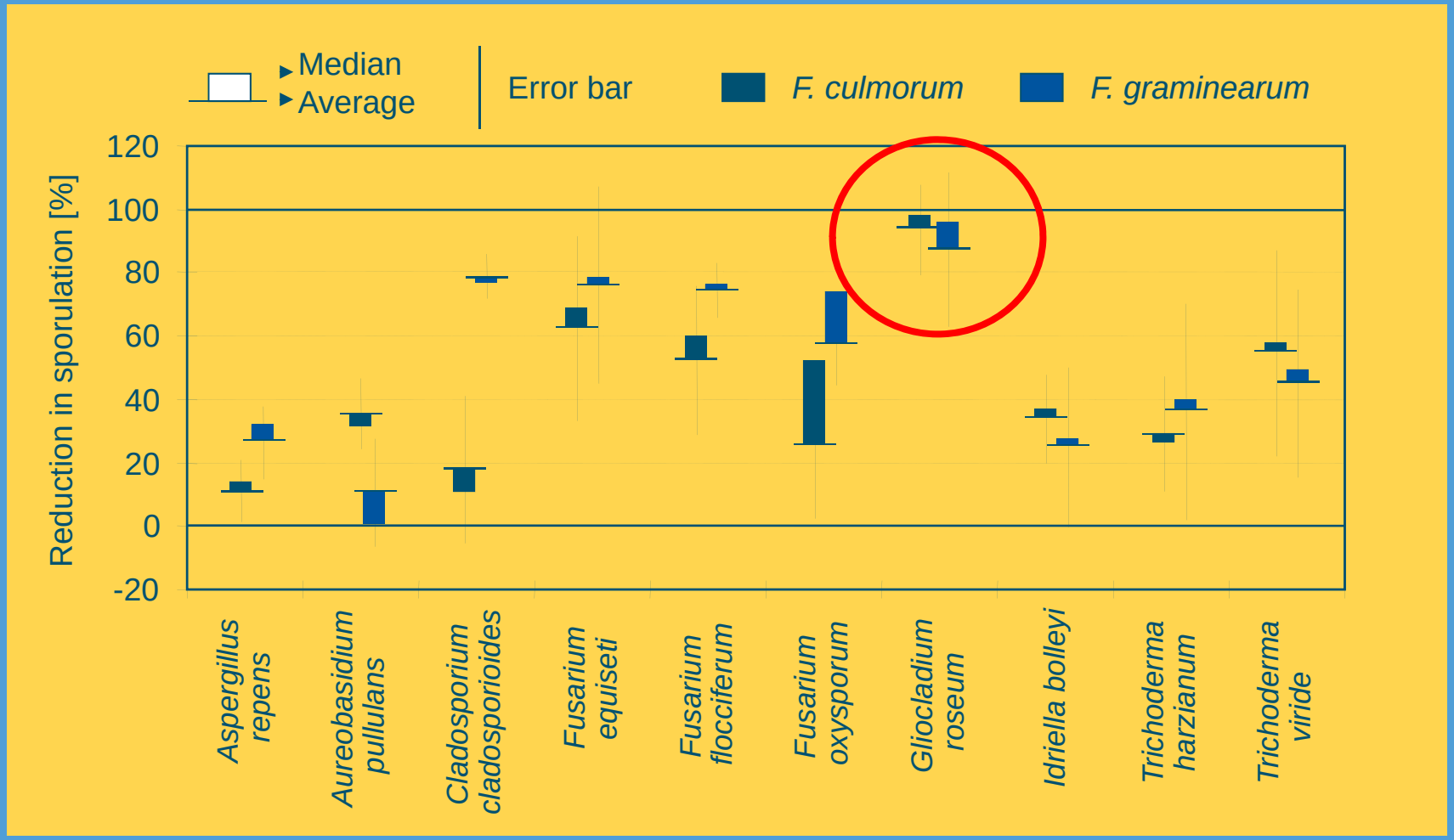
- 85 fungi, 10 yeasts, 2 bacteria tested (not known as human- or plant-pathogenic, suitable for mass production)
- 15% of tested isolates efficient (>90%) against *F. culmorum* and *F. graminearum*

Effectivity of antagonists (%) against *Fusarium* spp.

Effectivity (%)	*F. culmorum*	*F. graminearum*
< 5	12	19
5 < 50	52	23
50 - < 90	14	39
≥ 90	22	19

Luongo et al., 2005. Biocontrol Science and Technology 15:229-242

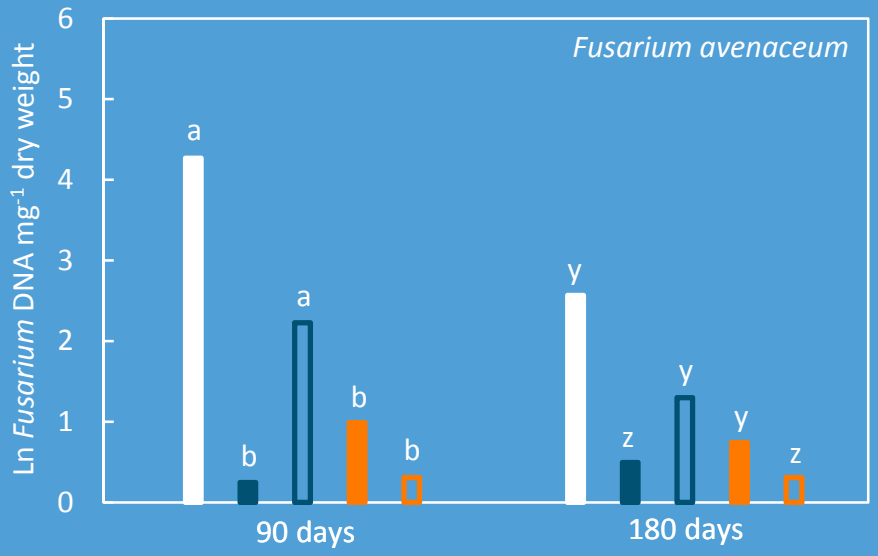
Antagonists screening: Fungal species

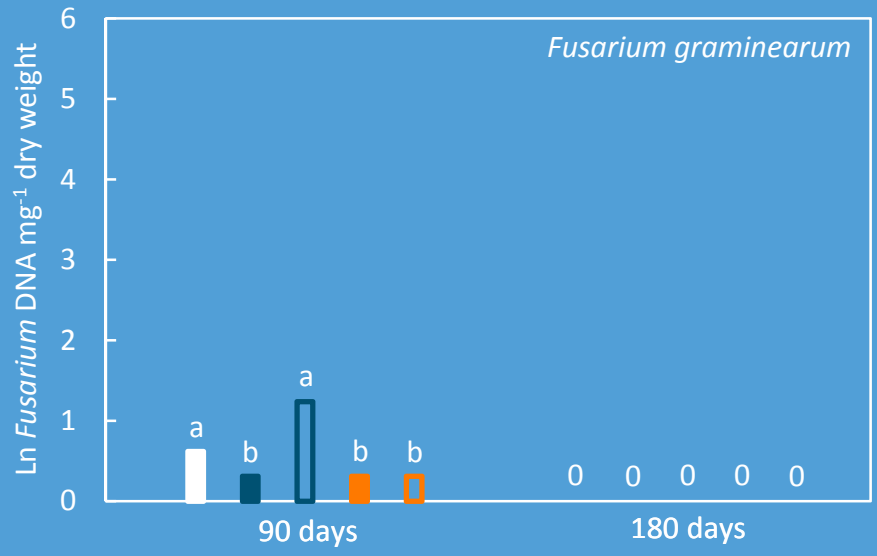


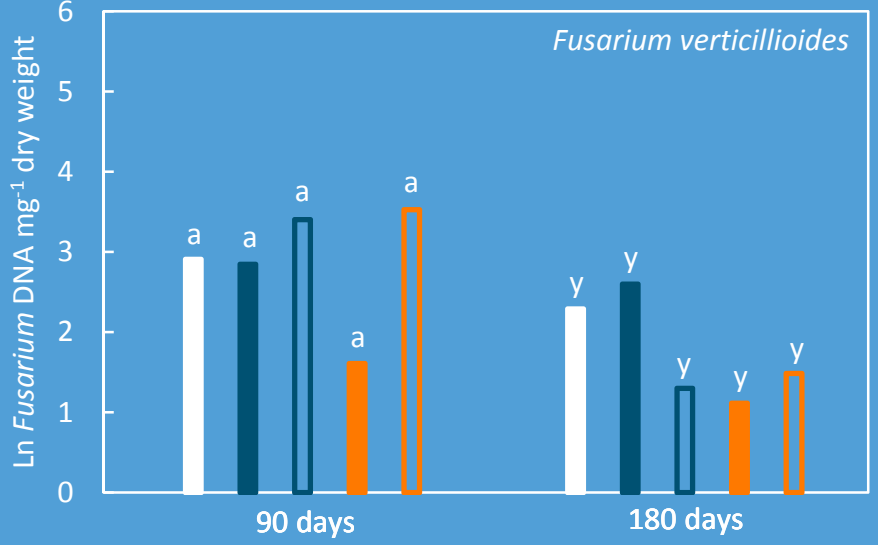
Field trials - Methods

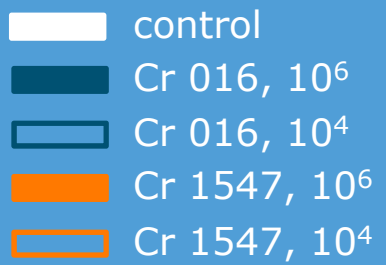
- 4 trials in Rio Cuarto and Marcos Juarez, Córdoba, Argentina in 2010 and 2011
- Wheat stalks (including stem base, 12 cm long) collected from commercial fields after harvest in December
- Treatments
  - Control (water)
  - *Clonostachys rosea* 016, $1x10^{6}$ conidia ml^{-1}
  - *Clonostachys rosea* 016, $1x10^{4}$ conidia ml^{-1}
  - *Clonostachys rosea* 01457, $1x10^{6}$ conidia ml^{-1}
  - *Clonostachys rosea* 01457, $1x10^{4}$ conidia ml^{-1}
- Treated wheat stalks exposed to field conditions on fallowed field soil for 180 days
- Assessment of *Fusarium* spp. colonization by TaqMan-PCR after 0, 90 and 180 days

Field trial Marcos Juarez, 2011



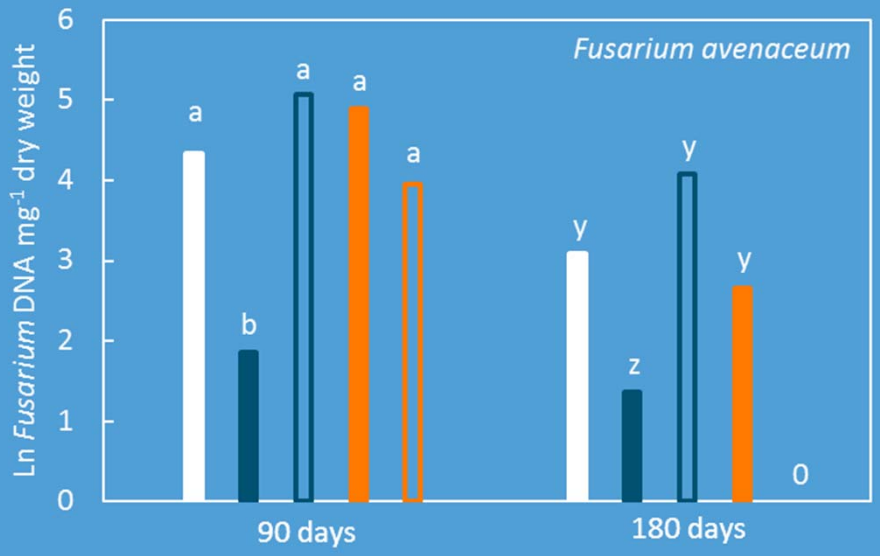


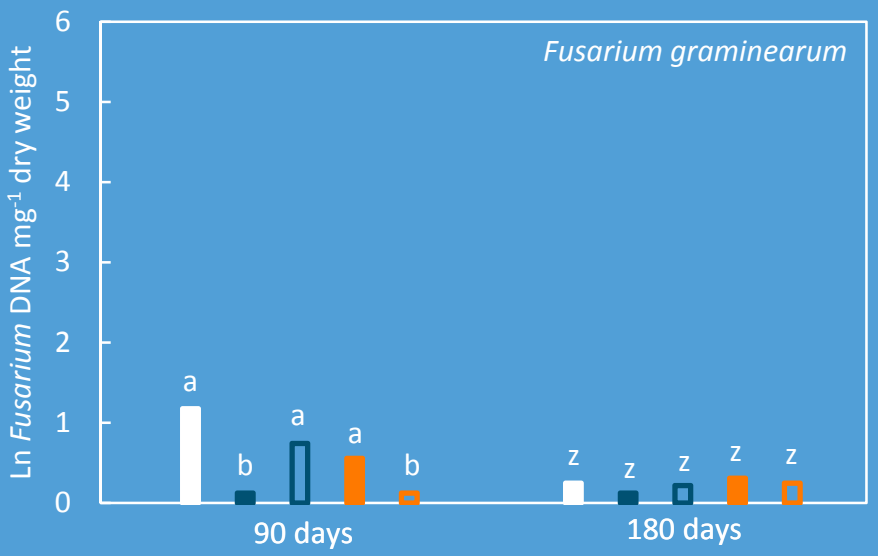


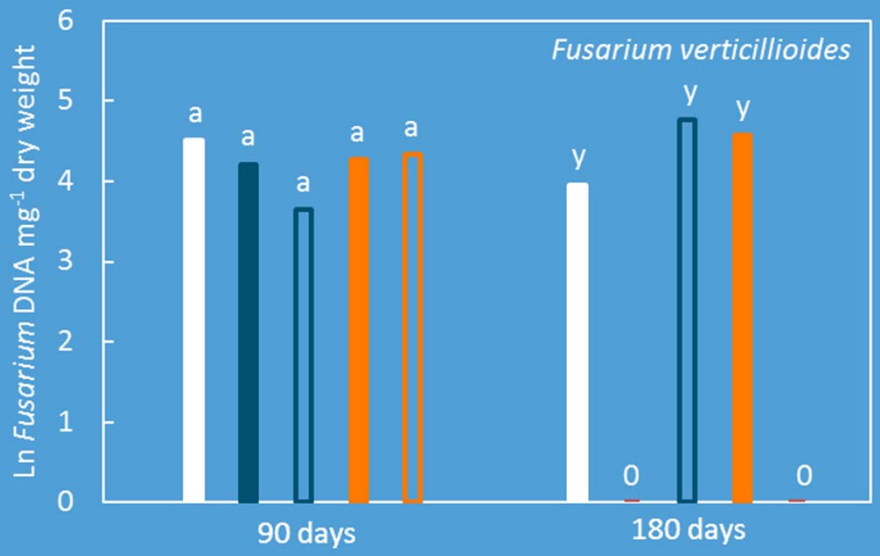


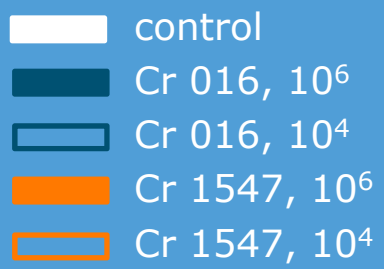
Palazzini et al., 2012. Plant Pathology
DOI:10.1111/j.1365-3059.02686.x

Field trial Rio Cuarto, 2011









Field trials - Conclusions

- *F. culmorum*, *F. poae*, *F. langsethiae*, *F. sporotrichioides*, and *Microdochium nivale* not present in wheat stalks
- *F. verticillioides*, *F. avenaceum* and *F. graminearum* naturally present in wheat stalks
- Natural decline of *Fusarium* spp. in wheat residues, but high levels of *F. verticillioides* and *F. avenaceum* present after 180 days
- *Clonostachys rosea* strains 016 and 1457 strongly reduced *Fusarium* spp. by up to 100%, but effects were not consistent
- Biocontrol effects of single treatments lasted 180 days

Summary

- New quantitative species-specific detection tools such as Taqman-PCR allow new insights in disease epidemiology important for the development of IPM
- Biological control agents can be used in crop residue management to reduce inoculum pressure of pathogens
- *Clonostachys rosea*:
  - High potential as BCA
  - Product formulation and scaling up
  - Full field trials
  - Development of full field application during or after harvest

Acknowledgements

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