"*Phakopsora euvitis*": an unusual biotrophic pathogen

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WORKSHOP FAPESP-BBSRC
Antimicrobial Resistance (AMR) and Insect Pest Resistance in Agriculture

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"Phakopsora euvitis": an unusual biotrophic pathogen

Grape diseases: epidemiology, damage assessment and control

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Rust – *Phakopsora euvitis*

Downy mildew – *Plasmopara viticola*

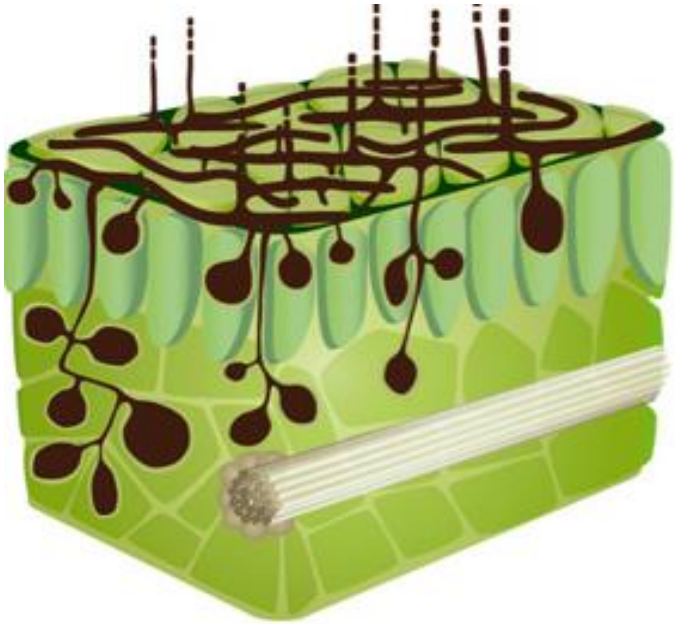
Anthracnose – *Sphaceloma ampelinum*

"*Phakopsora euvitis*": an unusual biotrophic pathogen

Trophic relationships between pathogens and plants

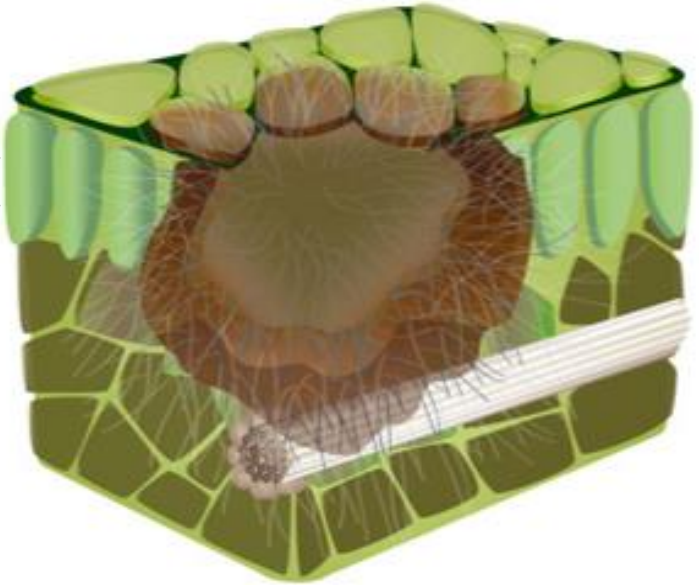
Biotrophic pathogens

Derive nutrients from living cells and, therefore, must maintain host viability



Necrotrophic pathogens

Actively kill host tissue as they colonize

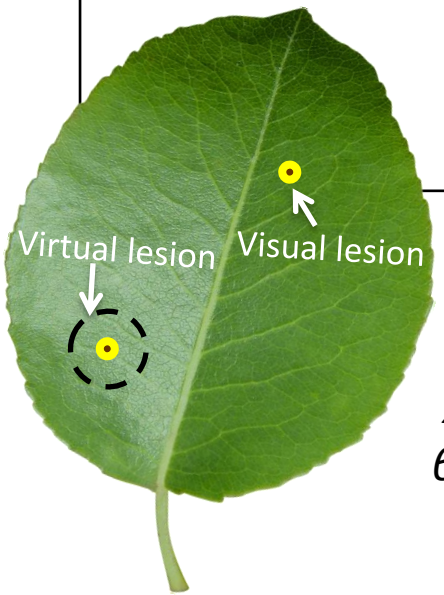


Garcia-Guzmán & Heil (2014)

"*Phakopsora euvitis*": an unusual biotrophic pathogen

Characteristic (Watkinson et al., 2015)	**Biotrophs**	**Necrotrophs**
Host range	Narrow	Broad
In vitro culture	Not possible If possible, not easy	Easy
Lytic enzymes	Localised to hyphae and limited quantity	Often copious with massive damage
Toxins	Not usually produced	Often produced
Host penetration	Usually through stomata	Directly through the cuticle
Damage to host tissue	No cell death during infection Reduction in photosynthesis restricted to the colonized tissue	Rapid cell death Reduction in photosynthesis can be high beyond to the colonized tissue

Characteristic	Biotrophs	Necrotrophs
Damage to host tissue	**Reduction in photosynthesis restricted to the colonized tissue**	**Reduction in photosynthesis can be high beyond to the colonized tissue**



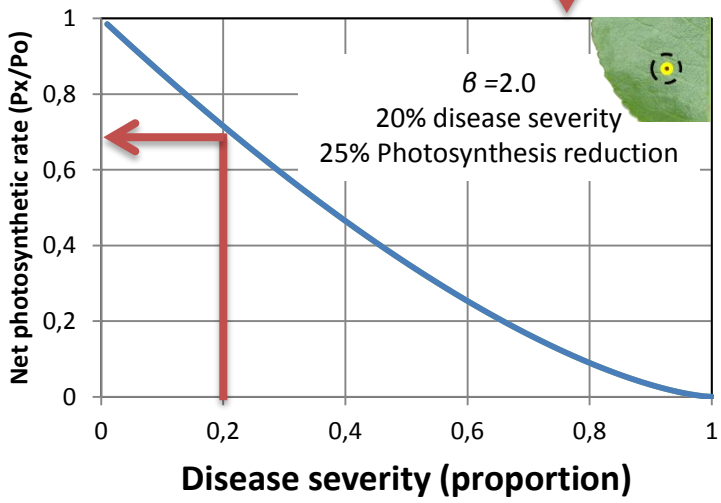
Bastiaans (1991)

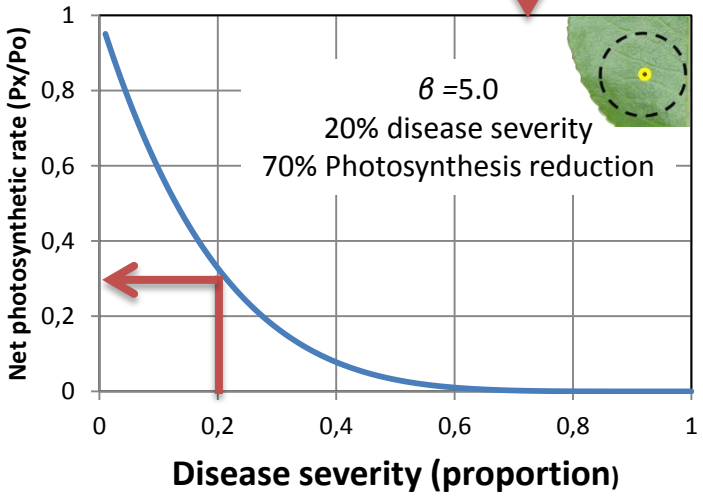
$P_x / P_o = (1-x)^{\beta}$

P_x – photosynthesis of diseased leaf; P_o – phtosynthesis of healthy leaf

x – disease severity (area of leaf with visual symptoms - in proportion)

β – "slope of the curve"





(Bastiaans, 1990; Spitters et al., 1990; Bassanezi et al., 2001; Robert et al., 2004)

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Characteristic	Biotrophs
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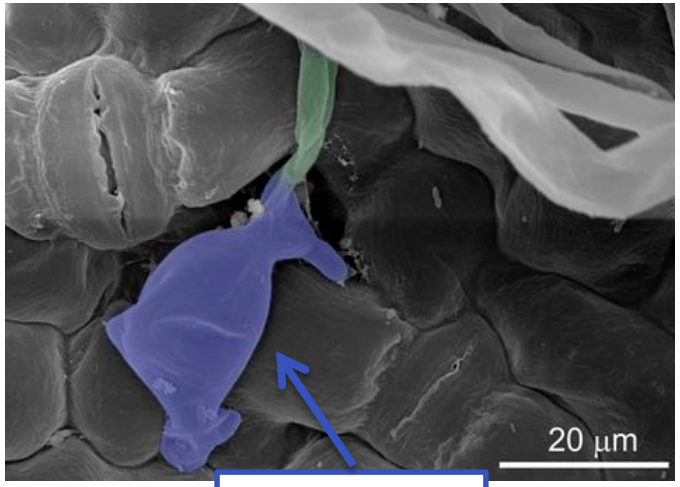

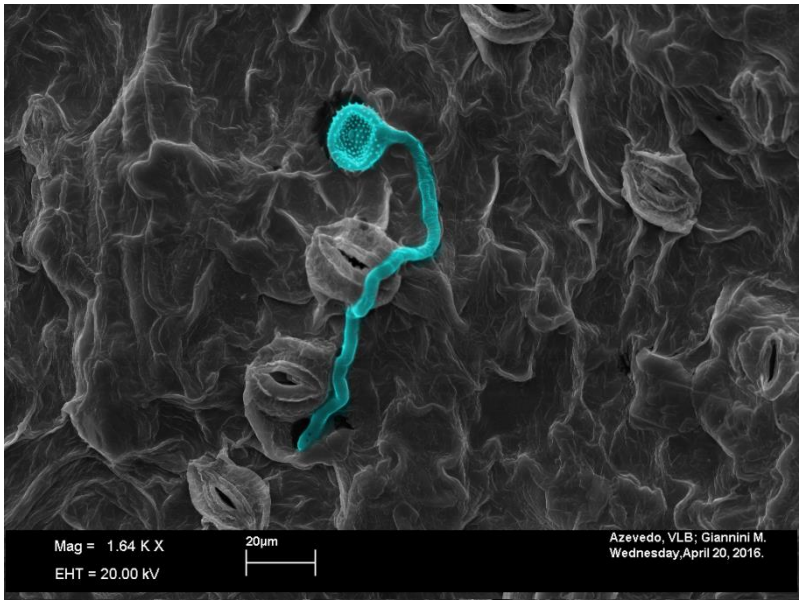

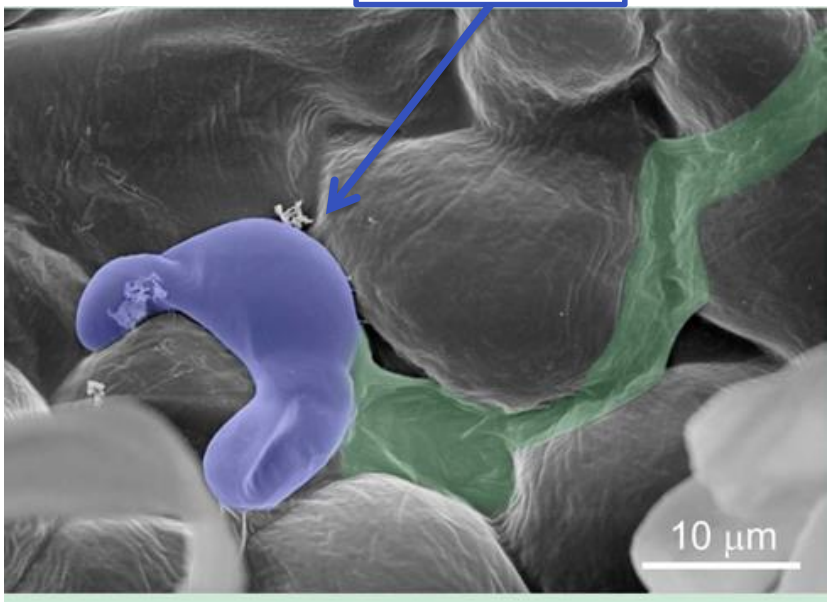

(Primiano et al., 2017; Rasera et al., 2017)

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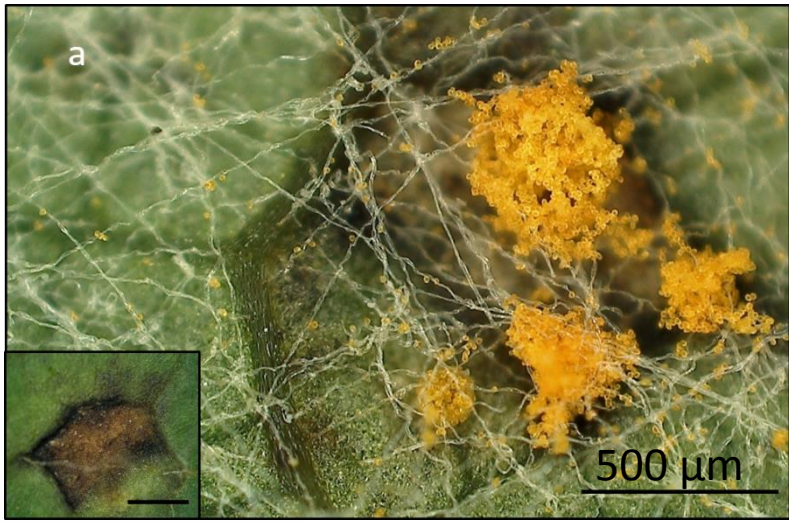

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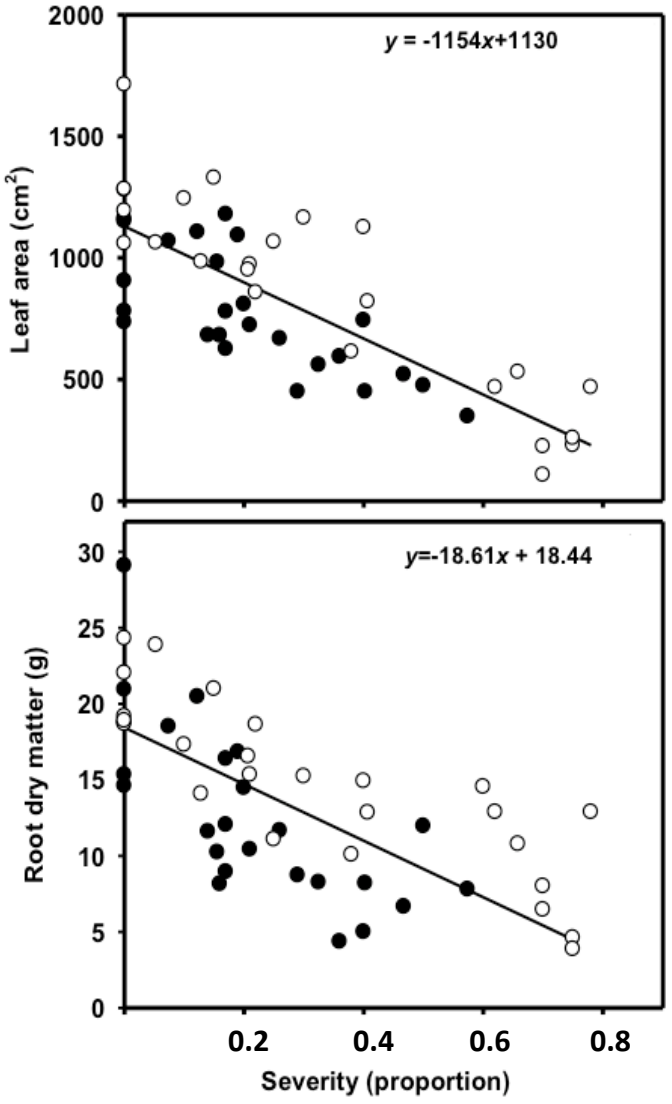

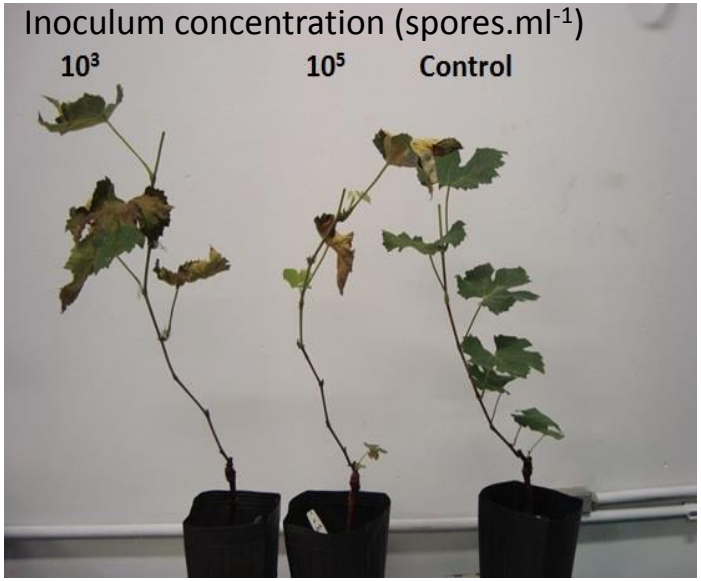

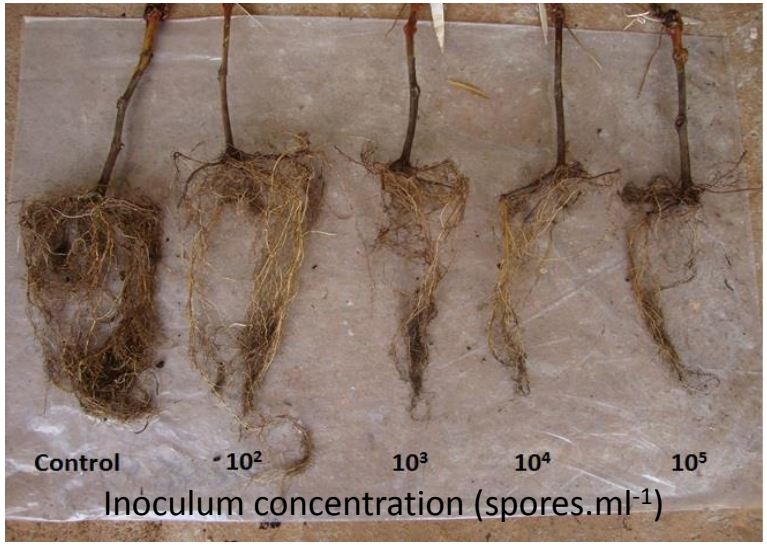

(Nogueira et al., 2017)

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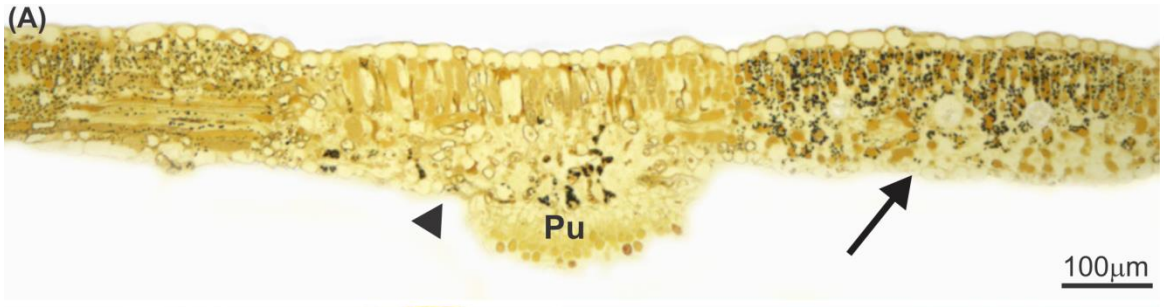
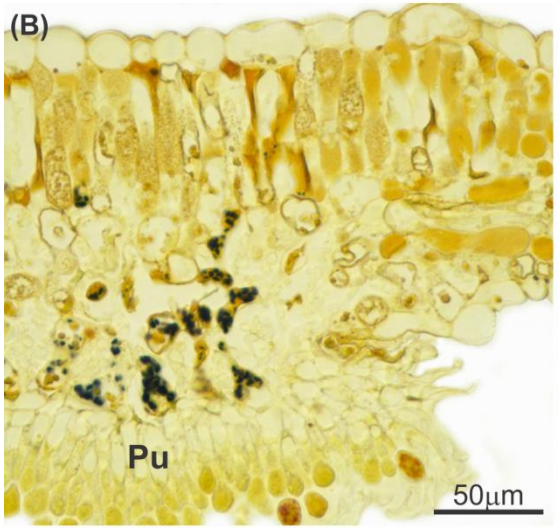




Diseased leaf

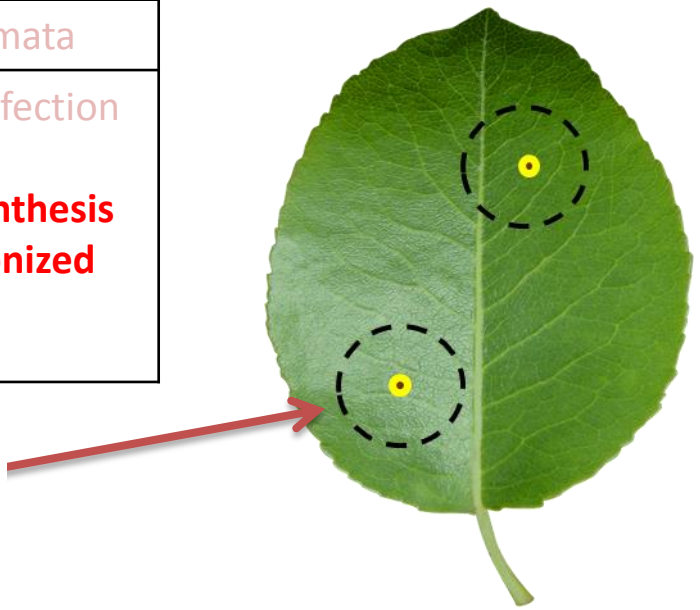
Starch accumulation after a dark period

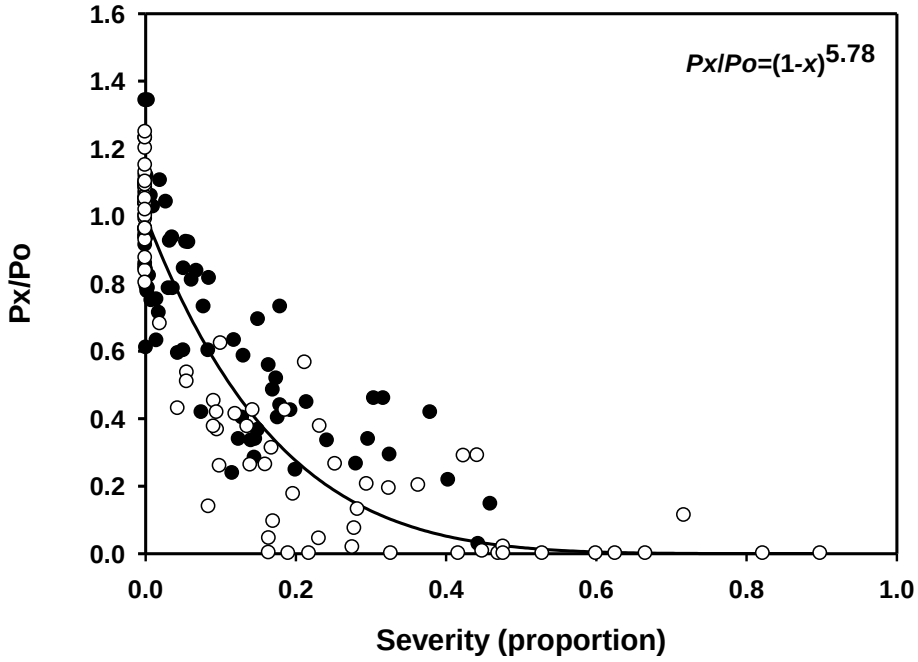
Healthy leaf

No starch accumulation

"Phakopsora euvitis": an unusual biotrophic pathogen

Characteristic	Biotrophs
Host penetration	Usually through stomata
Damage to host tissue	No cell death during infection **Reduction in photosynthesis restricted to the colonized tissue**





(Nogueira et al., 2017)

Relationship between the relative net photosynthesis rate (*P*x / *P*o) and rust severity. Circles are observed data in two experiments and line is the fitted model.

(Bastiaans, 1990; Spitters et al., 1990; Bassanezi et al., 2001; Robert et al., 2004)

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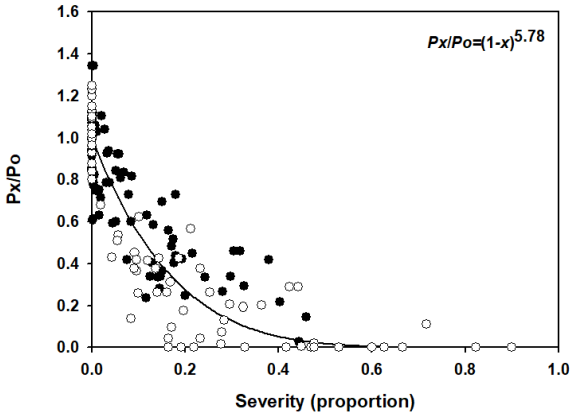
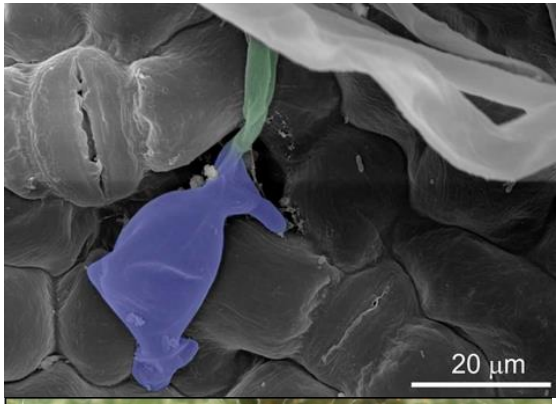
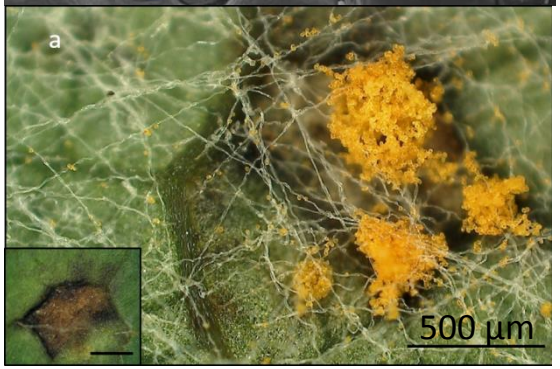
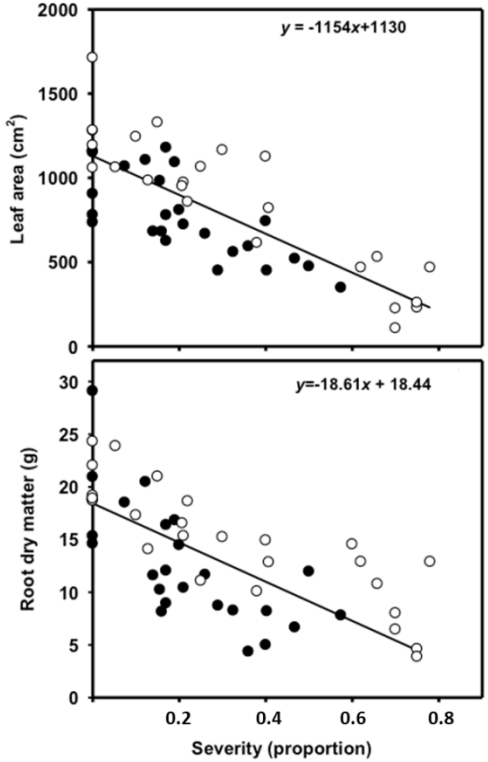
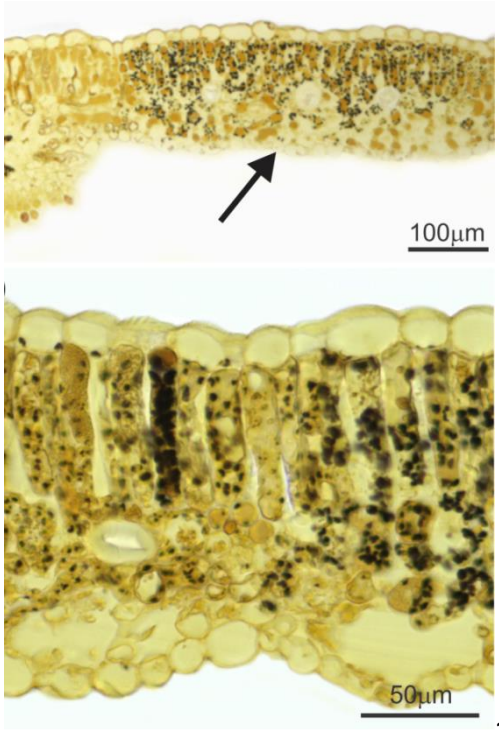


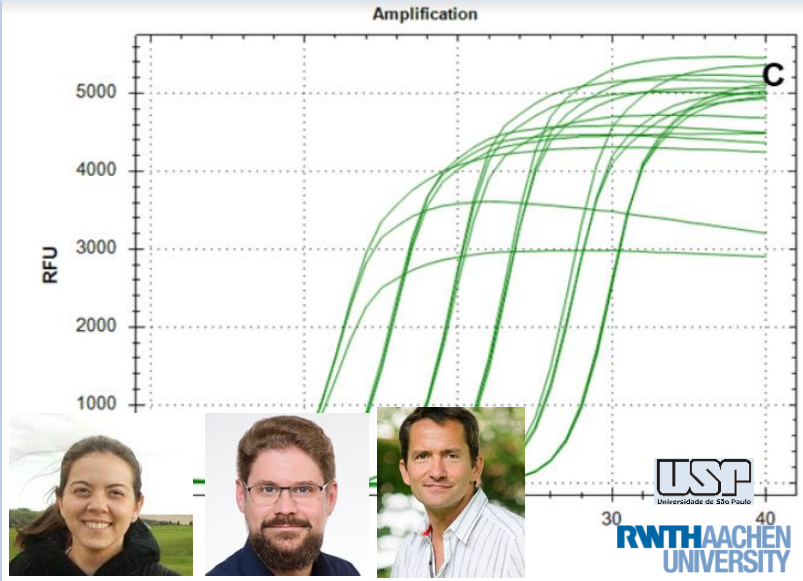






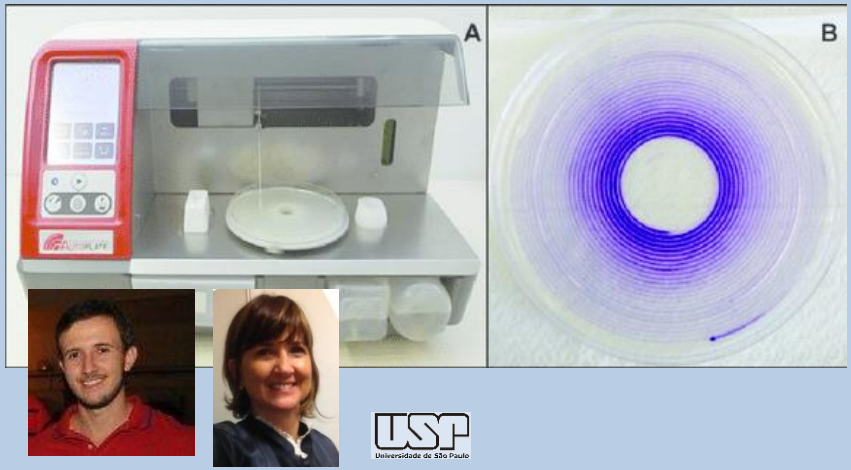


Infection mechanisms (effectors?)

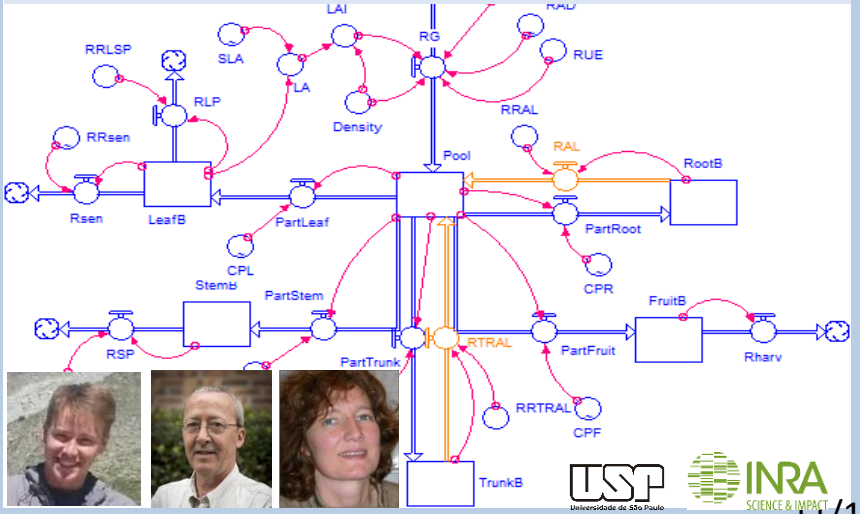


Effect of plastic cover on leaf photosynthesis under field conditions

Population sensitivity to QoI and DMI fungicides



Long term effect of the disease on yield (simulation modelling approach)



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