Does Zymoseptoria tritici accelerate leaf apical senescence in winter wheat plants cv. Soissons grown under contrasted nitrogen conditions?

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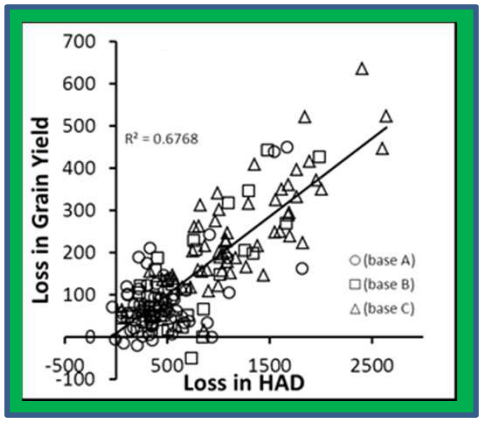
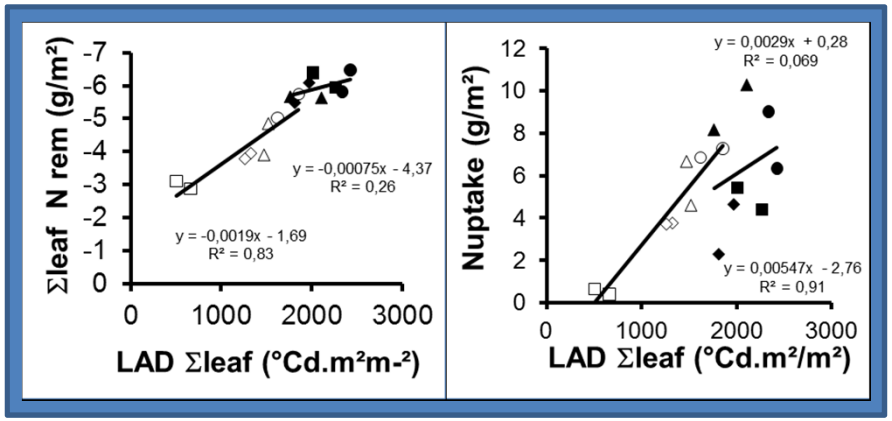
Context

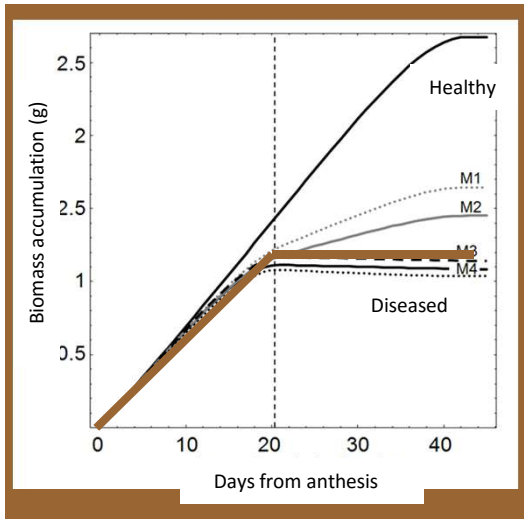
* Quantitative losses were previously well related to green leaf area losses (e.g. Robert et al., 2004; Bancal et al., 2007; 2015)

* Qualitative losses also in relation to decrease in both late N uptake and N remobilisation to grains (e.g. Bancal et al., 2008)

* Once green leaf area losses are taken into account, main damages also are (Robert et al., 2004)







Understand and simulate damages = understand and simulate GLA losses

Context : GLA losses in diseased leaves have 2 components

Green Leaf Area = Leaf Area - Apical Necrosis

GLA = LA - [Symptomatic Areas + Apical Necrosis]

Local senescence of symptomatic areas induced by Zt development:

- Necrotic areas with pycnidia
- Necrotic areas around sporulating zones

under different genetic controls

Is apical necrosis (i.e. whole plant functionning) modified in the the presence of Zt ?

- Faster N remobilization due to N blockage in dead tissues?
- N diverted for fungal growth ?
- Obturated vessels unable to feed tips ?

Context

A 1st experiment used cultivar resistance and isolate virulence to create variations in the setting of disease

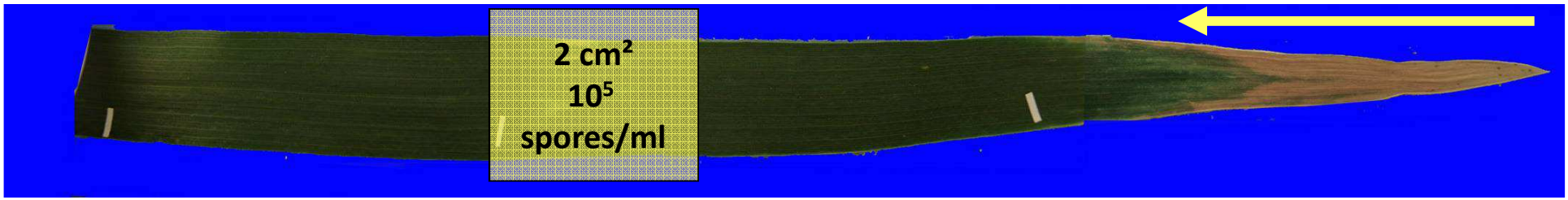
	Apache	Caphorn	Koréli	Soissons
Isolate *i1*	++++	+++	+	++++
Isolate *i2*	++++	+++	+	++++
Isolate *i3*	+++	-	-	++++
Isolate *i4*	+	-	-	+

Suffert, pers.com.

Inoculation was localized close to leaf ligulae to follow as far as possible apical senescence progression

Paintbrush inoculation by Zt:
Symptom appearance and extension

Apical necrosis with acropetal progression



Acceleration of apical senescence was never observed

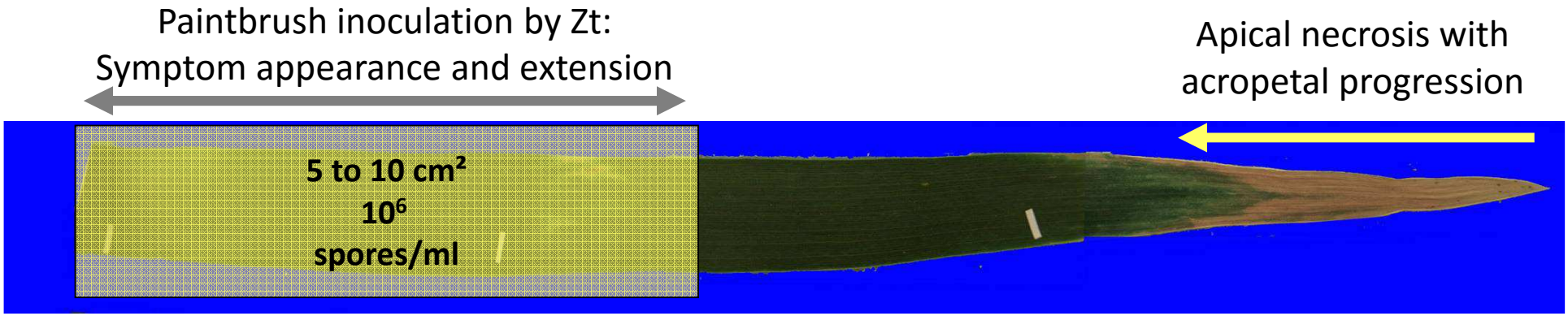
Ben Slimane et al, 2012

Objectives

→ Under a wider range of disease and senescence dynamics, does Zymoseptoria *tritici* accelerate or not apical senescence in winter wheat leaves ?

Means

- Inoculating 1/3 (I5) and 2/3 (I10) of leaf area



- Under varying nitrogen nutrition post-inoculation

→ to vary apical senescence dynamics
→ to vary symptom dynamics

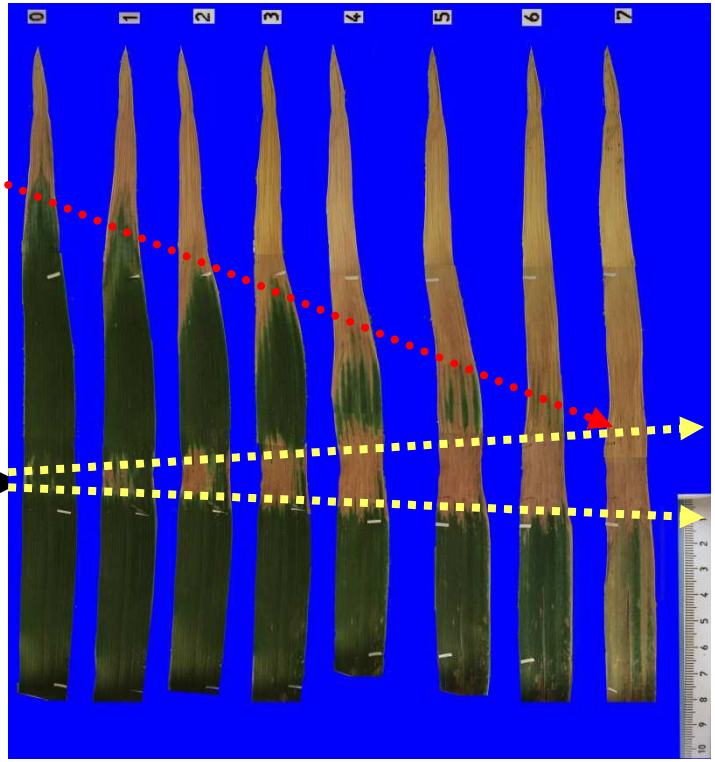
- Using a unique compatible susceptible cultivar (*Soissons*) x agressive isolate (*IPO323*) interaction

Material and Methods

Taking sequential numerical photos : two times a week, symptoms evolution (Ssep and Pycnidia Like Symptoms: PLS) as well as apical senescence(Sapi) up to the time they merged were estimated from image analysis. Non inoculated control leaves were measured as well.

Apical senescence surface area
Sapi evolution

Inoculated area by Z. tritici
→ **Ssep evolution**
→ **Number of Pycnidia-Like-Symptoms** (PLS) on symptomatic areas



1 cultivar x 1 isolate

2 Nitrogen nutritions post-inoculation

Inoculation on 0/3 (control) 1/3 or 2/3 of leaf area

8 repetitions per treatment

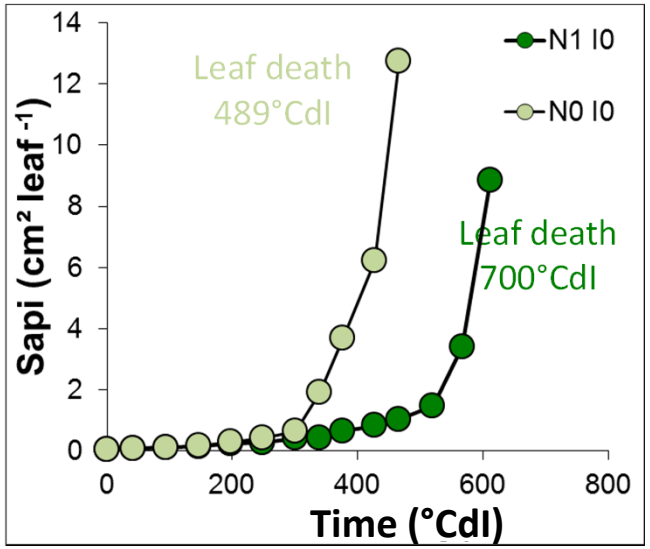
48 leaves assessed over time

As described in ***BenSlimane et al, 2012***

Results

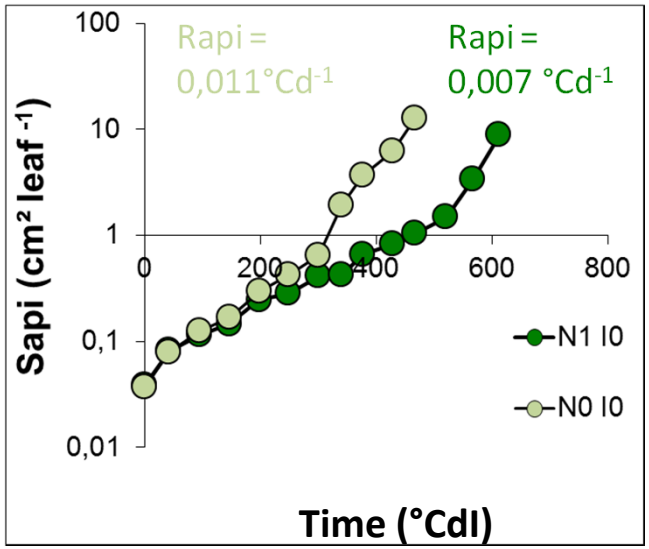
1- Impacts of N nutrition on apical senescence

Apical senescence surface



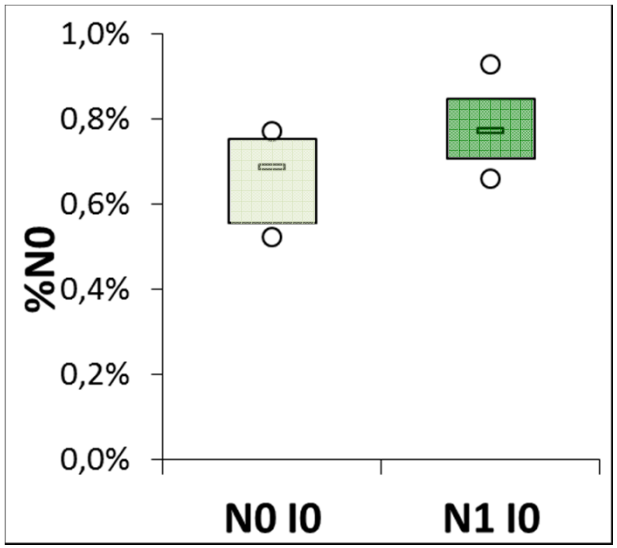
Larger and earlier apical senescence in case of N starvation (N0)

Rel.Rate of Apical senescence



Relative rate of senescence increased in N0 treatment

Residual N content in leaf apex



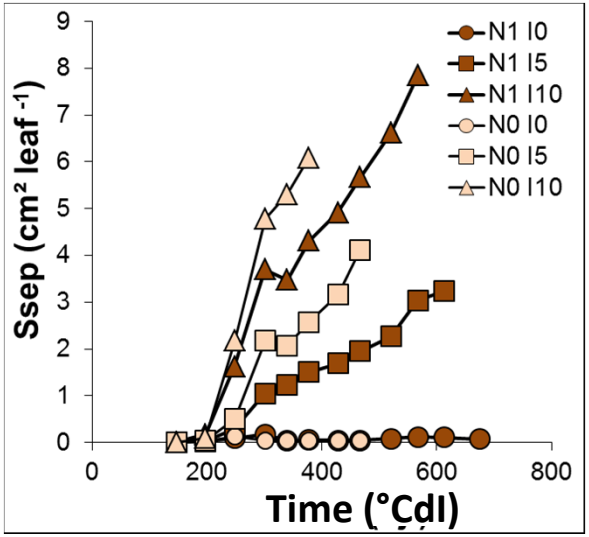
Lower residual N content in apical zone of N0 leaves

As expected, a large range of apical senescence dynamics was created by the means of late nitrogen nutrition

Results

2- Impacts of N nutrition on symptoms development

Necrotic symptomatic surface

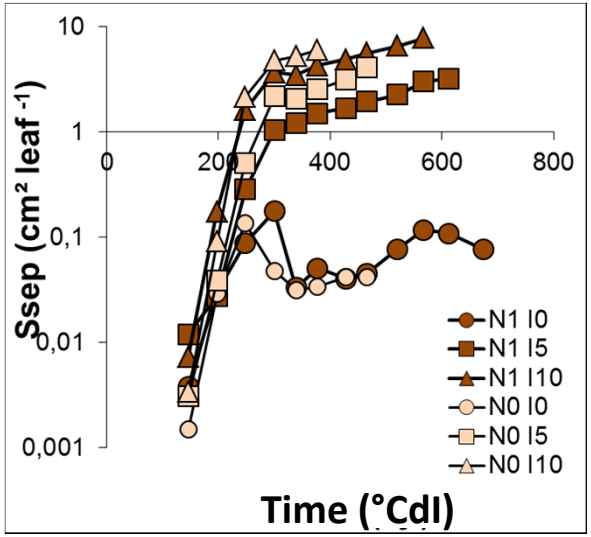


Apparition in 2 phases

Ssep appeared earlier and at a higher rate in I10 vs I5 leaves

Local necrotic area was increased as early as 300°CdI under N0 by 1.25 times but stopped at lower values

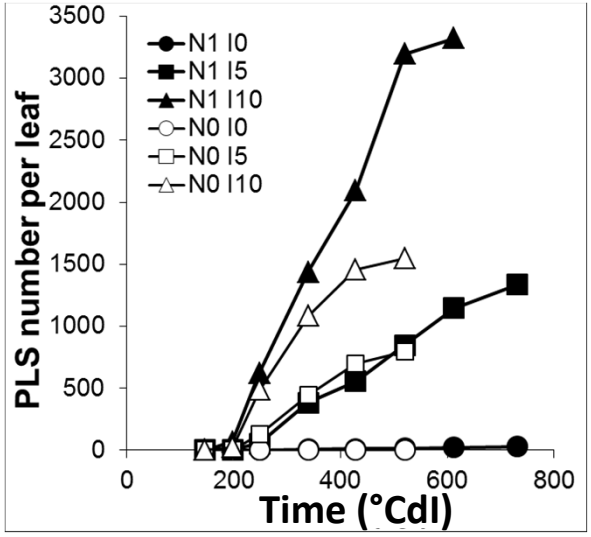
Rate of symptom development



Symptom development followed a bi-exponential law, the switch being between 250 and 300°CdI.

Only early rates of Ssep were significantly increased under N0 by 1.7 times in I5 leaves

Nb of Pycnidia like structures



Pycnidia followed the same 2-phases dynamics as Ssep

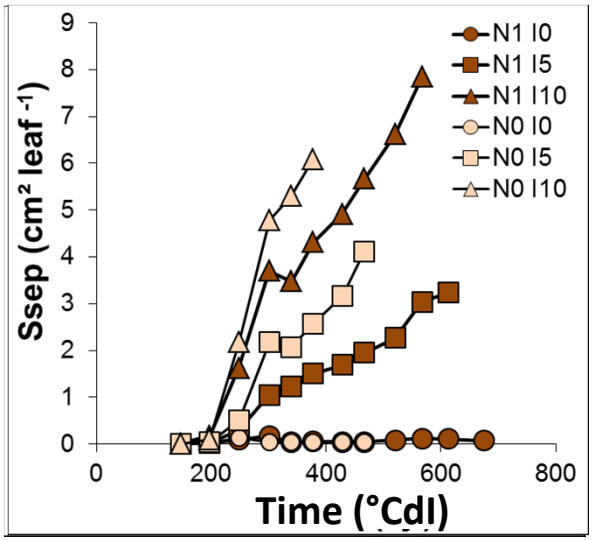
But either the rate or the final PLS number per leaf was lower under N0

A large range of Septoria tritici blotch dynamics was created and the response to leaf nitrogen characterized

Results

2- Impacts of N nutrition on symptoms development

Necrotic symptomatic surface



Apparition in 2 phases

Ssep appeared earlier and at a higher rate in I10 vs I5 leaves

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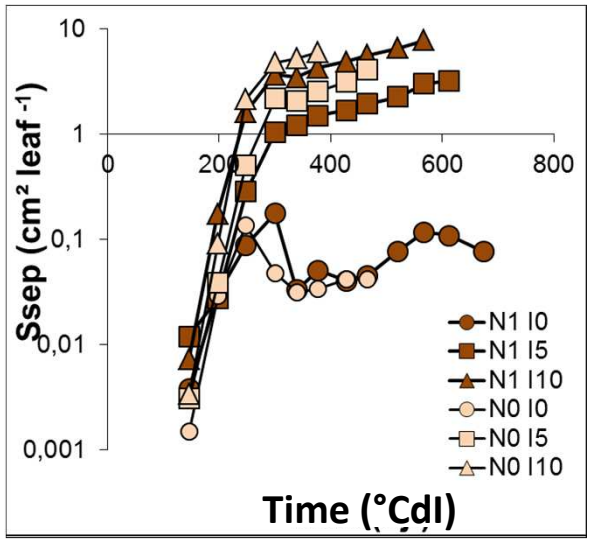

Symptom development followed a bi-exponential law, the switch being between 250 and 300°CdI.

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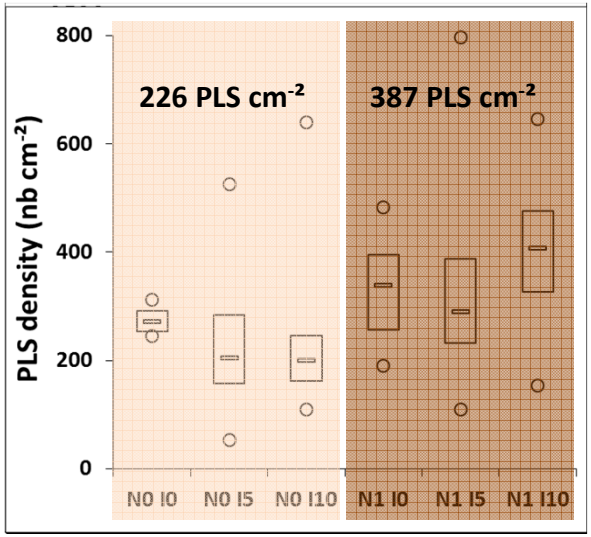
Nb of Pycnidia like structure



Pycnidia followed the same 2-phases dynamics as Ssep

But either the rate or the final PLS number per leaf was lower under N0

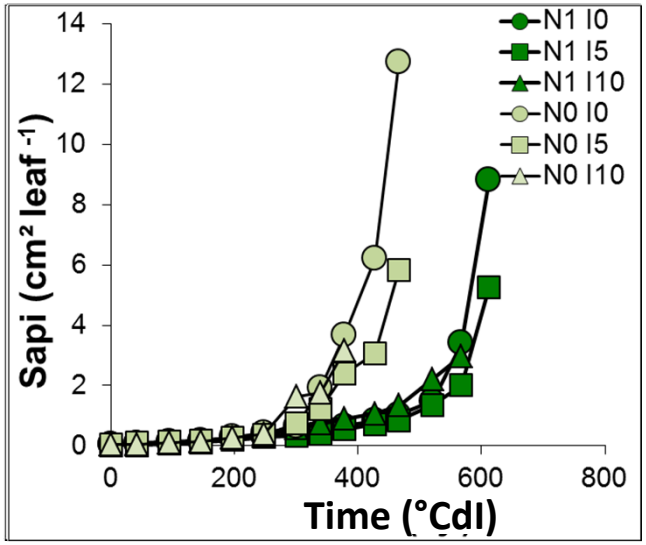
Thus PLS density was about 1.7 times higher in N1 than in N0 leaves

A large range of Septoria tritici blotch dynamics was created and the response to leaf nitrogen characterized

Results

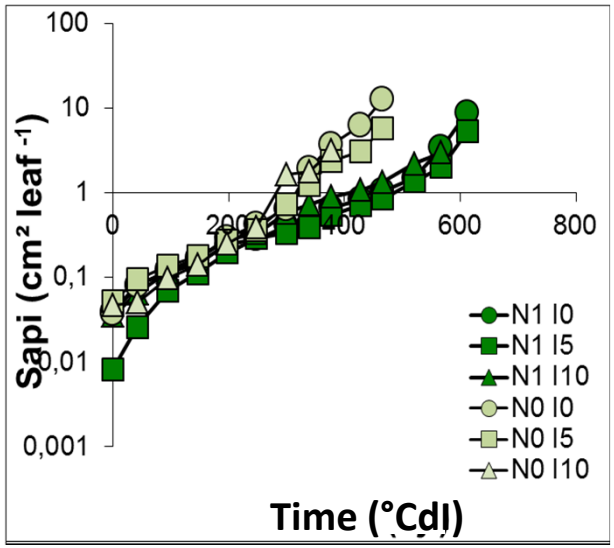
3- Impacts of symptom development on apical senescence

Apical senescence surface



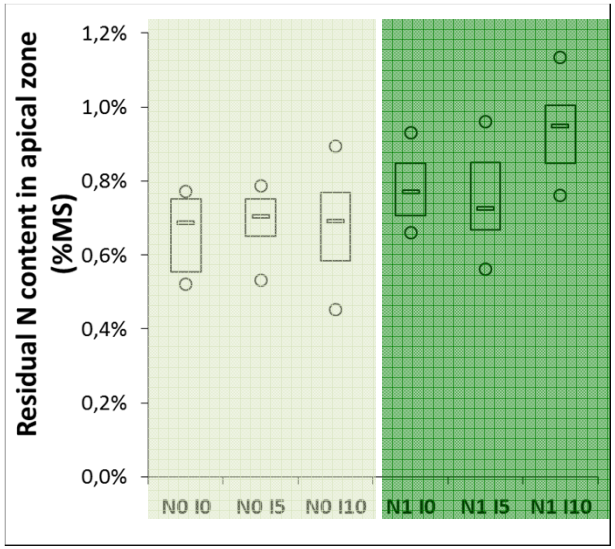
Apical senescence was not increased at all by localized inoculation up to 2/3 of leaf area

Rel.Rate of Apical senescence



The relative rate of apical senescence remained unchanged after large localized inoculations

Residual N content in leaf apex



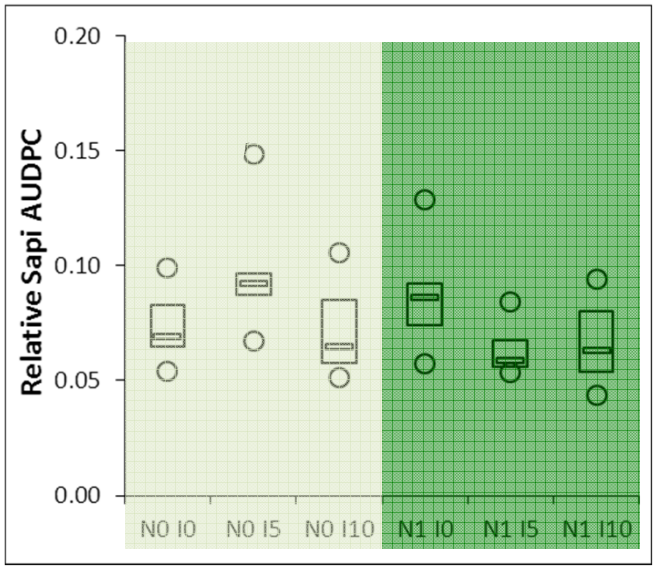
Residual N content in apical zone was not significantly modified by localized inoculation

Neither leaf apical senescence area or rate was modified by large localized inoculations with Septoria tritici blotch

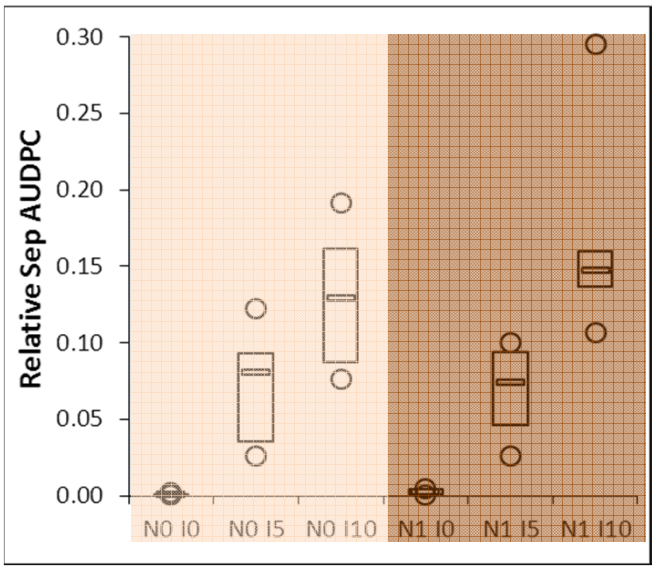
Results

4- Impacts of nitrogen on relative GLA losses

AUC Sapi (relative to HAD of healthy control) of N1 or N0 treatments



AUC Ssep (relative to HAD of healthy control) of N1 or N0 treatments



No impact at all of nitrogen nutrition on both AUDPCs of diseased leaves:

Relative non-GLA are the same, so the damages are the same

Discussion

1- Apical senescence is never accelerated by STB

- In a range of large inoculation areas
- In a range of Sapi dynamics via variation in N nutrition

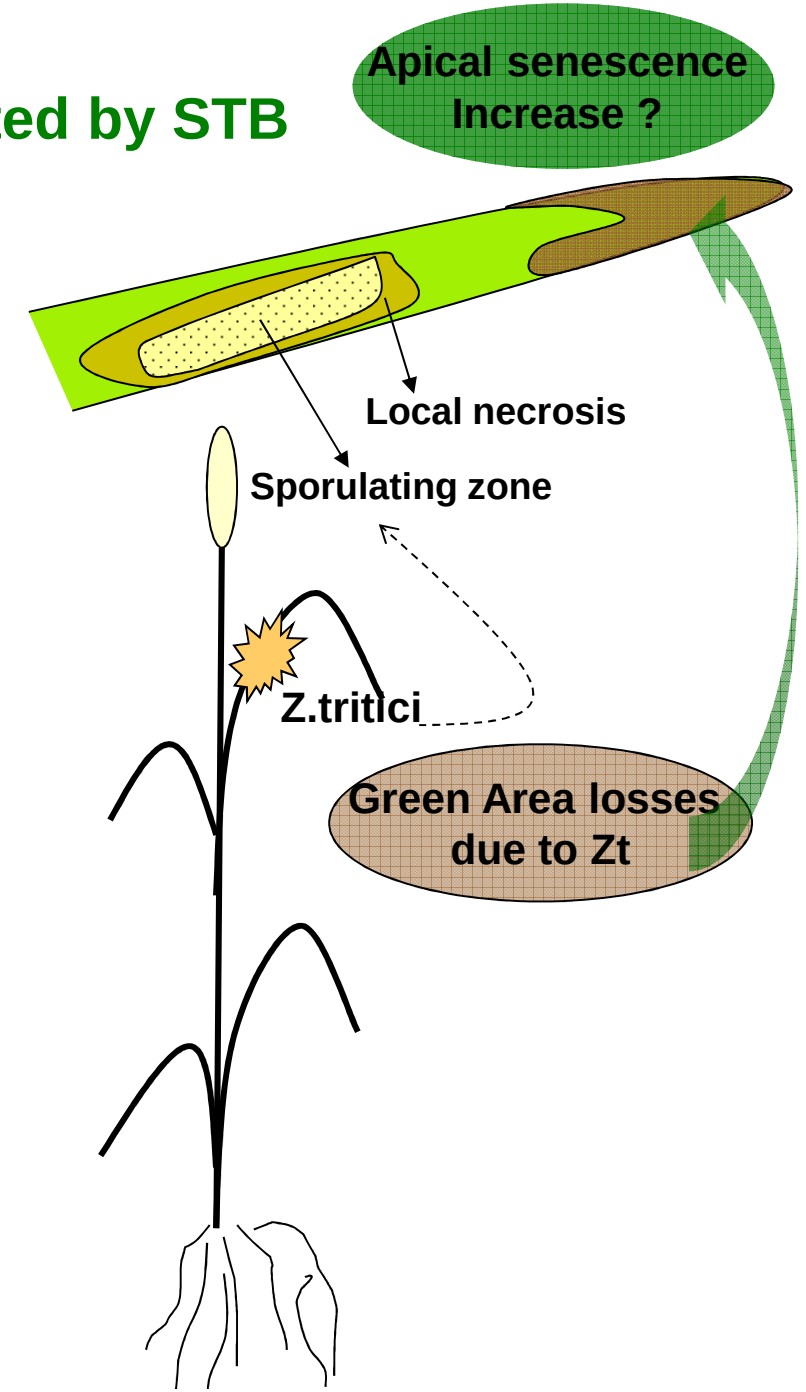
→ Residual N content in non-inoculated apex zone remains unchanged

It confirms and extends previous results

2- Late N nutrition interacted with Zt dynamics

- Low N increased necrosis extent
- Late N icreased the number of Pycnidia per leaf conversely to necrosis

→ Pycnidia density is increased by high N nutrition



Discussion

3- Whatever late N nutrition, relative GLA losses are the same

- Even with the large range of Sapi and Ssep created,
  once HAD of control leaves is taken into account,
  overall damages relative to control leaves are the same

Conclusion : in a modelling perspective of damages

- Understanding and modelling Sapi in healthy leaves
  is sufficient to predict Sapi in diseased leaves

- Necrotic area depends on leaf N nutrition, even lately varied:
  quantitative relationships have to be established thoroughly
  and may depend on isolate x cultivar interaction

- Final pycnidia number was increased by late N nutrition:
  so far, its relationship to damages was not established
  and may also depend on isolate x cultivar interaction

Acknowledgements

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UMR AGROPARISTECH

Thanks for your attention!