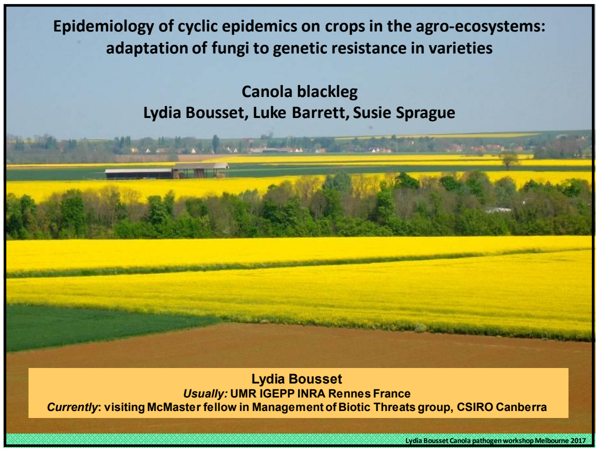
Epidemiology of cyclic epidemics on crops in the agro-ecosystems: adaptation of fungi to genetic resistance in varieties

Canola blackleg

Lydia Bousset, Luke Barrett, Susie Sprague



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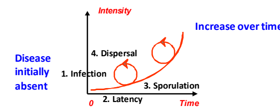
Currently: visiting McMaster fellow in Management of Biotic Threats group, CSIRO Canberra

What do we mean by "epidemics"?

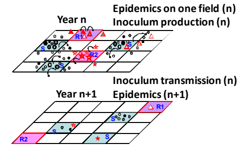
Small scale: continuous processes

In space: increase of foci

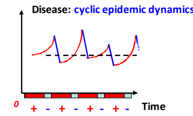
In time: dynamics of increase / life cycle of the fungus



Wider scale: discontinuous processes



=> The epidemics in successive years are not independent

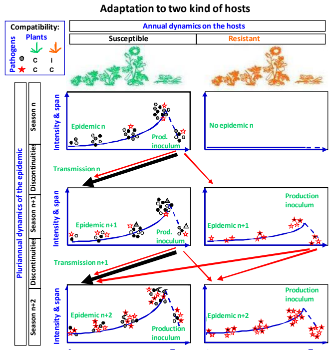


- Change in hosts fields after harvest
- Seasonality in climate suitability

=> The transmission from fields (year N) to fields (year N+1) matters for the dynamics

Adaptation of fungal pathogens to plant resistance = puriannual on several fields

Adaptation to two kind of hosts



if resistant fields contribute inoculum
=> Loss of efficiency

Breeding can increase the potential for durability of the varieties

=> But adaptation dynamics depends on the carry-over of inoculum

Carry-over of inoculum?

Adaptation dynamics depends on the carry-over of inoculum

Need for modelling the cyclic dynamics

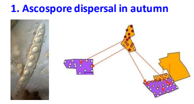
Ex: landscape scale models / resistance management strategies & populations' adaptation

Empirical data on adaptation dynamics:

A need to test model's predictions
A need to compare resistance gene deployment strategies

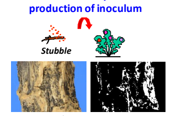
Canola blackleg fungus

1. Ascospore dispersal in autumn



Bousset et al. 2015 Annals Appl. Biol.
Bousset et al. 2016 EJPP

2. Picture analysis for production of inoculum

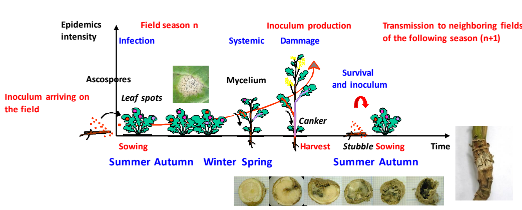


Brassica Conference 2016 Melbourne

3. Field experiment to compare deployment strategies

Today

Life cycle of *Leptosphaeria maculans*



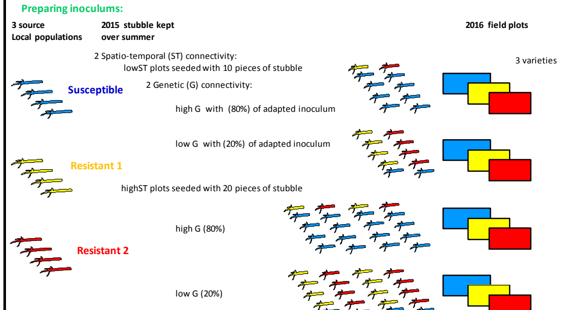
Survival on stubble -> we can simulate contrasted transmission events

Genetics of resistance is known -> we can simulate contrasted successions of resistance genes

Question: if we mix inoculums, will we see the effect on the population size and composition?
-> aim at simulating contrasted genetic and spatio-temporal connectivities

Ginninderra's field experiment: contrasted genetic and spatio-temporal connectivities

Preparing inoculums:

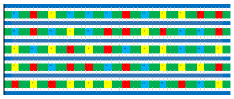


15 treatments:
12 inoculated: 2 levels of spatio-temporal connectivity
x 2 levels of genetic connectivity
x 3 host resistance genotypes
3 uninoculated controls (one for each host resistance genotype)

X 4 repetitions

Ginninderra's field experiment

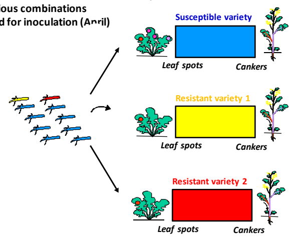
15 treatments
x 4 rep
= 60 field plots




Sowing and inoculating field plots

Resulting populations on field plots
July November

Various combinations used for inoculation (April)



Population size: leaf spots severity

Estimate of population size = counting numbers of leaf spots / 1 square meter / 1 minute (mid-July) (Bousset et al. 2016 EJPP)

For each plot: 3 counts (= 3 observers) on the same quadrat

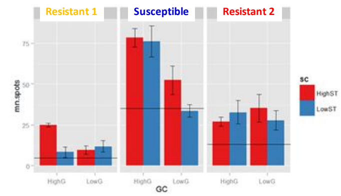
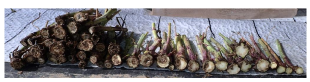


Fig 1. Summary figure showing mean spots per treatment. Error bars show standard error. Black line is the mean number of spots in the uninoculated control plots

Population size: canker severity


Estimate of population size = mean of cankered area on section



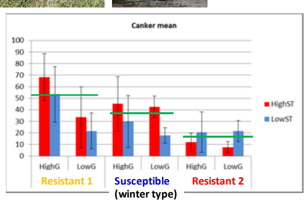
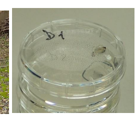


Fig 2. Summary figure showing mean cankered area per treatment. Error bars show standard error. Green line is the mean cankered area in the uninoculated control plots

Population composition: obtaining the isolates

2015 stubble kept

Initial populations: recovering single ascospores from the fruiting bodies on stubble

3 sources x 30 isolates

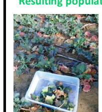
S

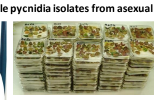
R 1

R 2

2016 Leaf spots

Resulting populations = recovering single pycnidia isolates from asexual fruiting bodies on leaf spots





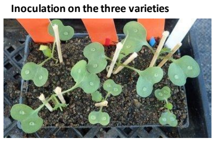
60 field plots x 30 isolates
(2400 frozen leaf spots)

=> Phenotyping for virulence

Population composition: phenotyping for virulence

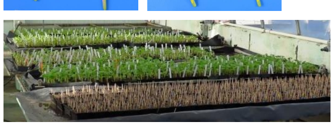
Production of spores under near-UV light

Inoculation on the three varieties



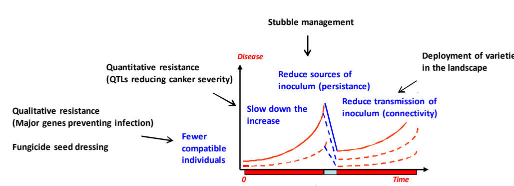
Scoring 14 days in comparison to standard isolates


Comparison of virulence frequencies depending on:
- Stubble mix
- Field plot variety



Ongoing work!

Prospects: combining methods to control cyclic epidemics?



Need for knowledge on resistances

Qualitative resistance: SABL project, interaction, variety testing, advice to farmers

Need for empirical data on inoculum & epidemics

Disease dynamics -> talk upper canopy infection
Persistence, transmission / stubble management -> talk spore release

Need for modelling the cyclic dynamics

landscape scale models / resistance management strategies & populations' adaptation
Current field plot experiment

Quantitative resistance: knowledge in Europe, protection (Brun et al. 2010; Delourme et al. 2015) -> Australia?

Thanks for

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GRDC

Thanks for your attention!

CSIRO Visiting fellow July 2016 – June 2017

Management of biotic threats group, invited by Luke Barrett + Susan Sprague

Sir Frederic McMaster fellowship