Recent advances in understanding PCN decline and their use in developing novel control strategies

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ROTHAMSTED RESEARCH

Rothamsted Research, Harpenden, Hertfordshire, AL5 2JQ

Biological Control of Plant – parasitic Nematodes

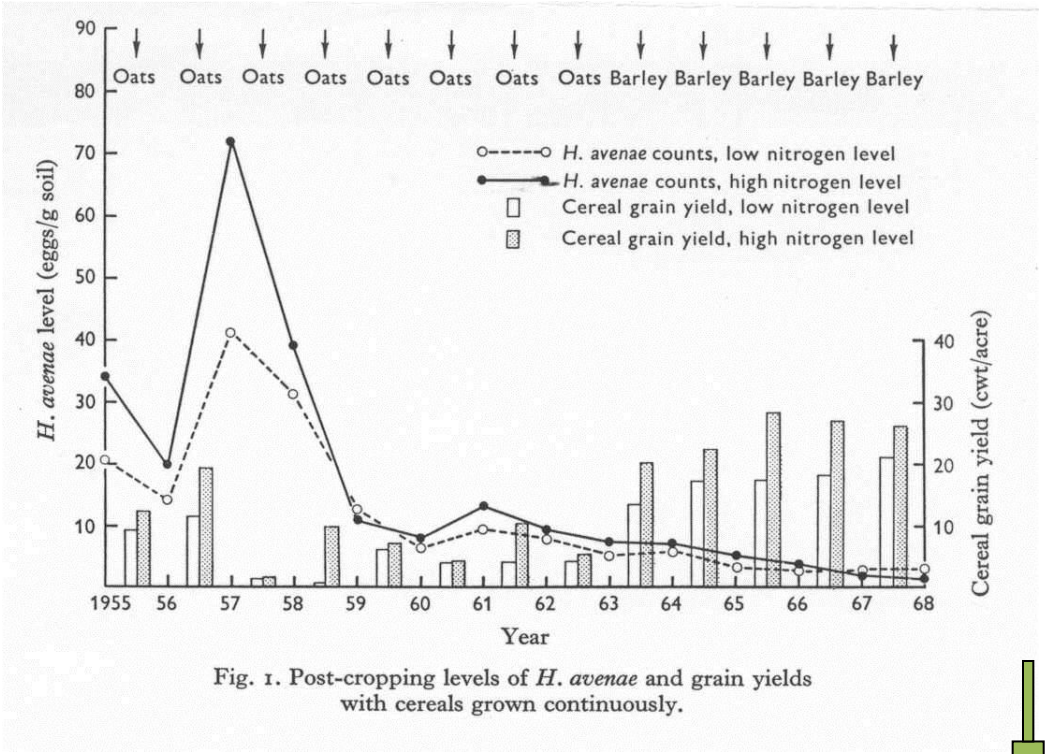
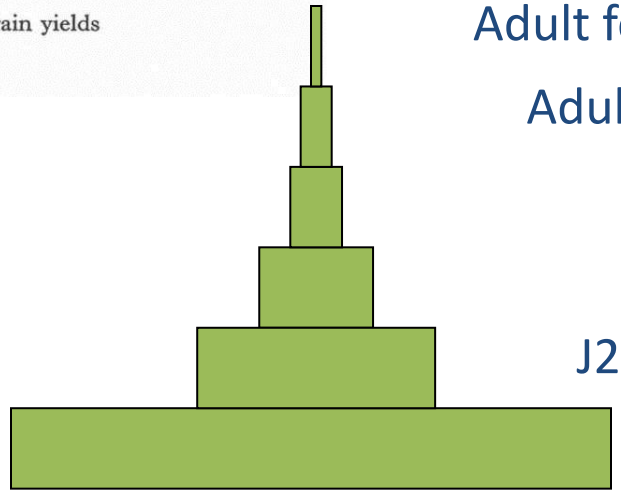


Fig. 1. Post-cropping levels of *H. avenae* and grain yields with cereals grown continuously.

(Gair *et al.*, 1969)



Adult females 3 %

Adult males 5%

J4 8%

J3 11%

J2 roots 25 %

Eggs 100 %

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Biological control organisms

1) Facultative parasites

Pochonia chlamydosporia
Paecilomyces lilacinus
Monographella cucumerina
Cylindrocarpon destructans
Arthrobotrys oligospora

2) Obligate parasites

Pasteuria penetrans
Nematothrora gynophila
Hirsutella rhossiliensis

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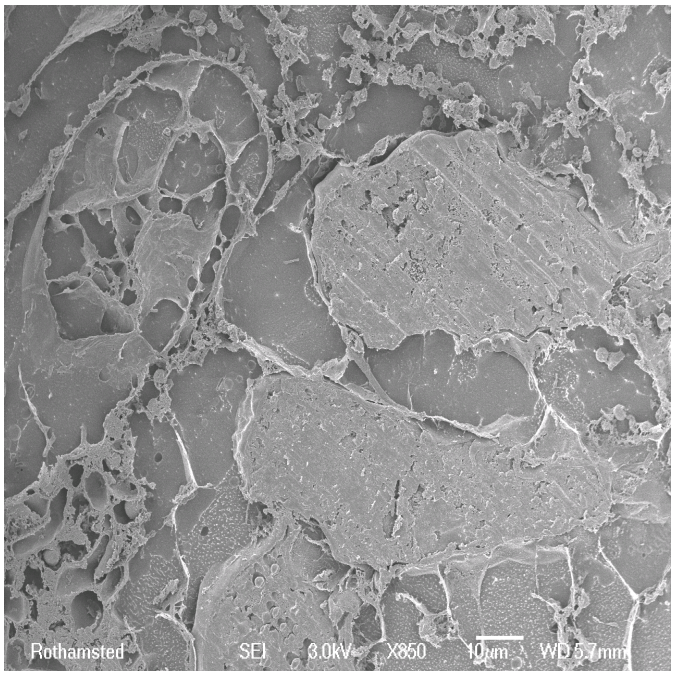
RESEARCH

Measurement of colonisation of cysts by egg parasitic fungi using cryo-scanning electron microscopy at 8 weeks

Control



Fungal treated

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PCN decline key objectives

Objective 1. To identify key factors that affect PCN suppression and decline rates

Objective 2. To develop new protocols for measuring decline rates in field soils

Objective 3. To investigate the influence of edaphic factors and cropping regimes

Objective 4. Assess effects of fungicides & herbicides on the associated microbes

Objective 5. Investigate the biotic and abiotic factors that influence fungal growth

Objective 6. Investigate potential formulation and delivery of fungal agents

Objective 7. Investigate effects of carbon and nitrogen acquisition on fungi

Objective 8. Assess the importance of fungal parasites in the patch dynamics of PCN

Objective 9. Assess the effects of different nematicides formulations

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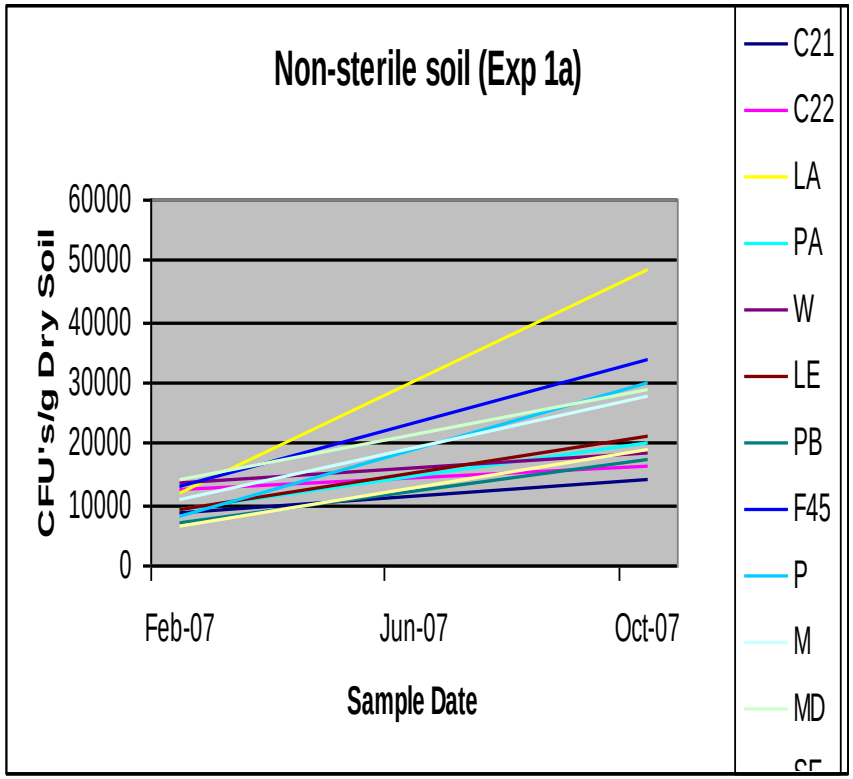
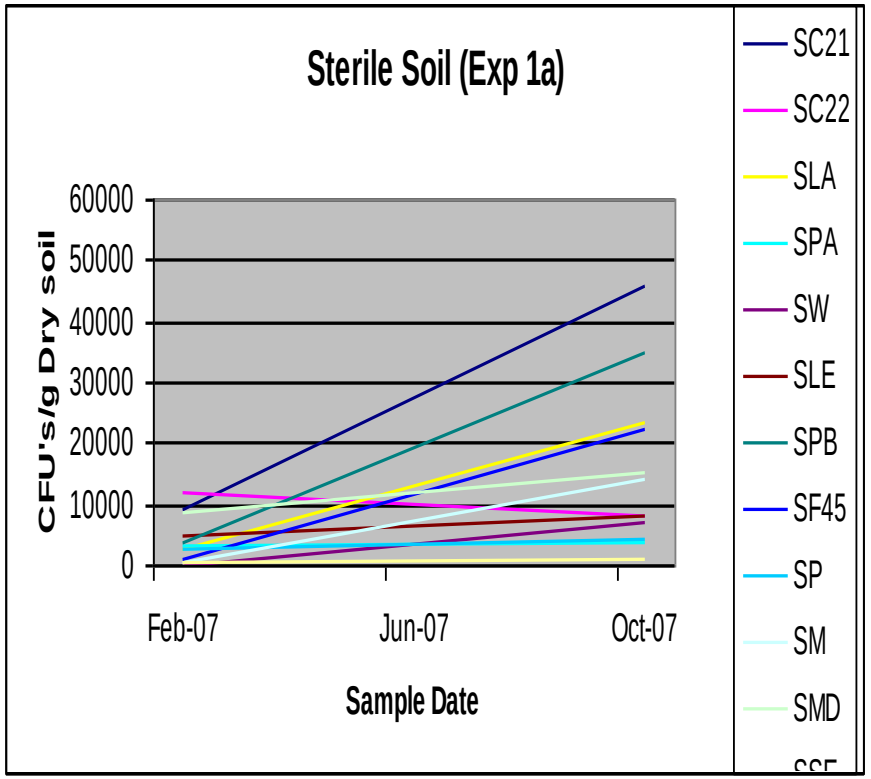
Objective 1: Assess the rates of decline in a range of soils of different textures and cropping histories

- Ten different soil types
- Samples divided into two one sub-sample sterilised
- PCN cysts placed in soil in mesh bags
- Sampling beginning and of each season over 3 years
- Egg counts done

Objective 1: Assess the rates of decline in a range of soils of different textures and cropping histories





Does sterilization have an effect on fungal communities?

Objective 1: Assess the rates of decline in a range of soils of different textures and cropping histories

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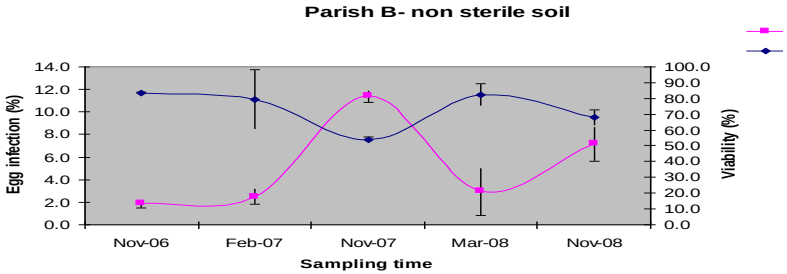

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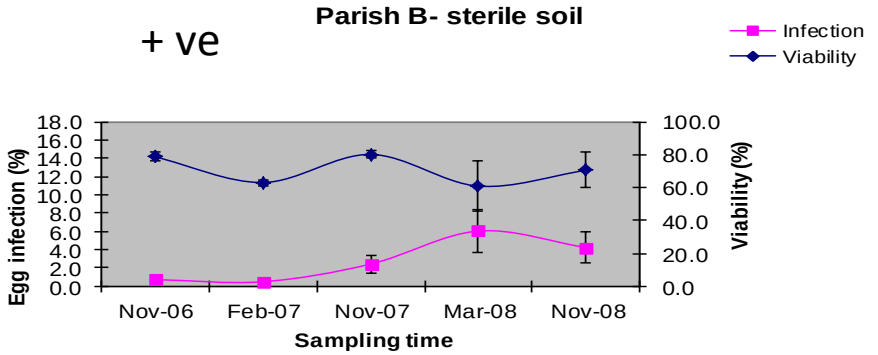

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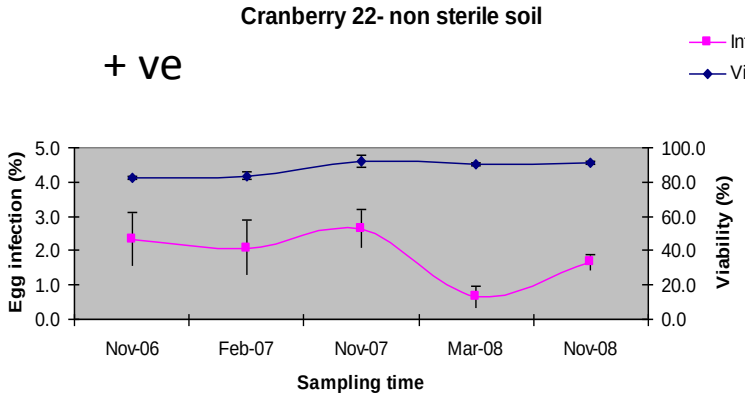

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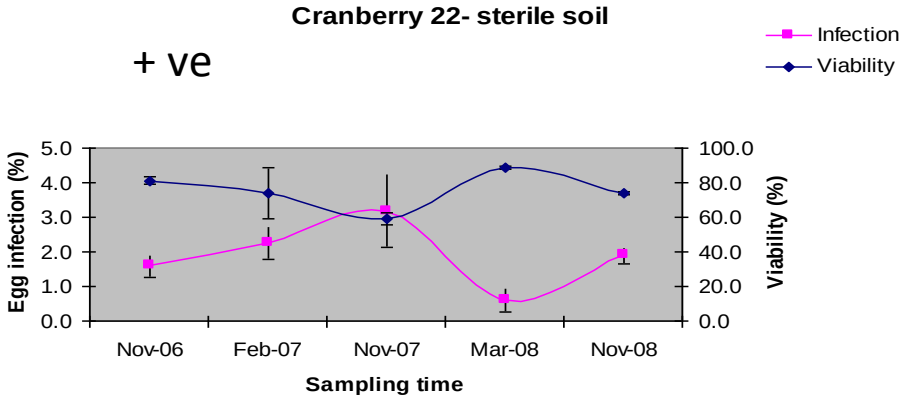

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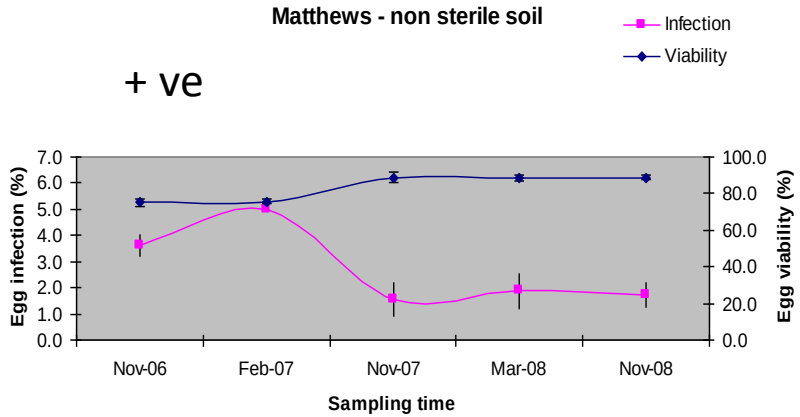
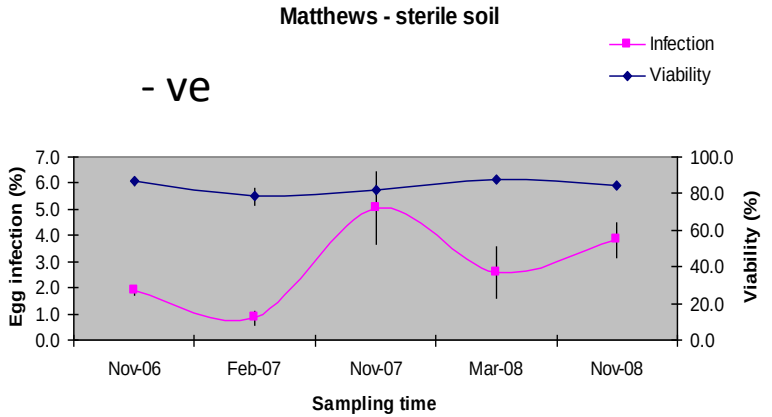
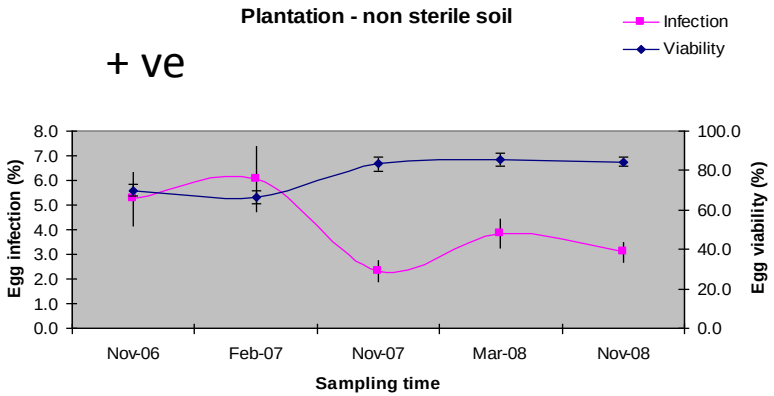
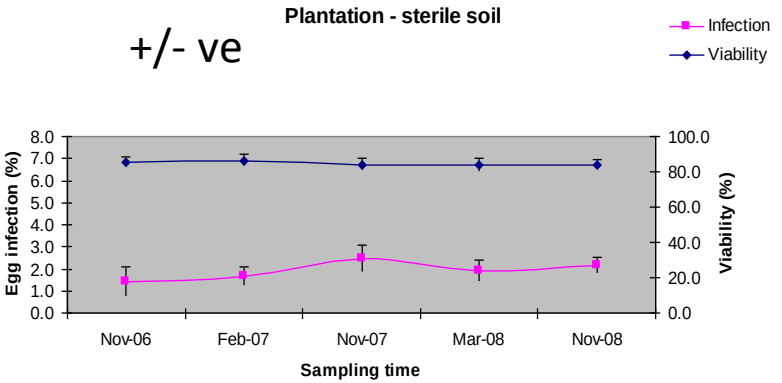








Objective 1: Assess the rates of decline in a range of soils of different textures and cropping histories

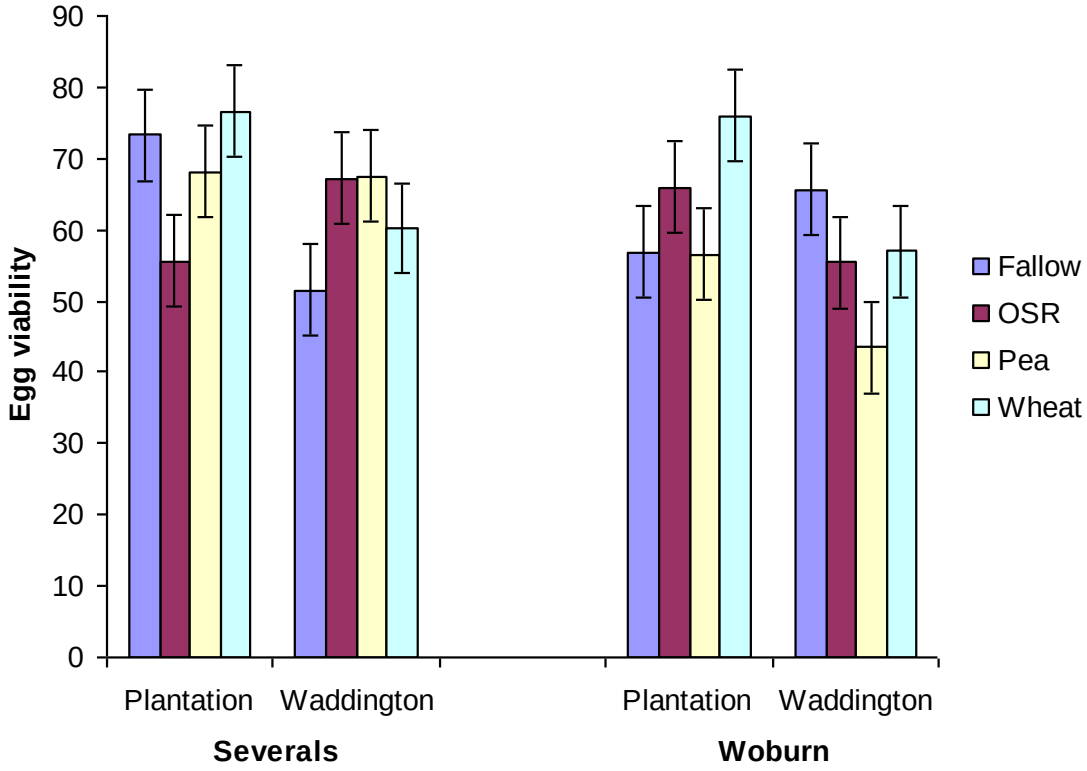
Summary

- Large amounts of variation makes interpretation problematic

- 40 % of the soils where the sterile soil showed the same +ve trend as non-sterile soil

- 10 % showed a negative trend between sterile vs non-sterile

Objective 3: Investigate the influence of various cropping regimes on PCN decline and potato yields



Effect of break crops

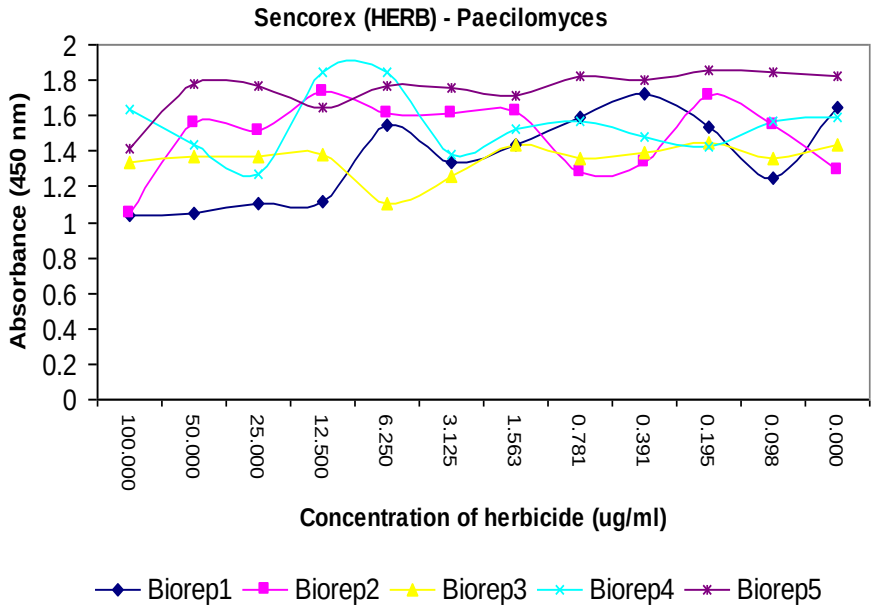
2 soils: Severals & Woburn

2 PCN pops: Plantation & Waddington

Very weak interaction $P < 0.05$ as measured by egg viability which was between 43.5 to 76.6 %

Objective 4: . Assess effects of fungicides & herbicides on the associated microbes

The effect of herbicide Sencorex (Metribuzin; photosynthesis inhibitor) on the growth of *Paecilomyces lilacinus*.

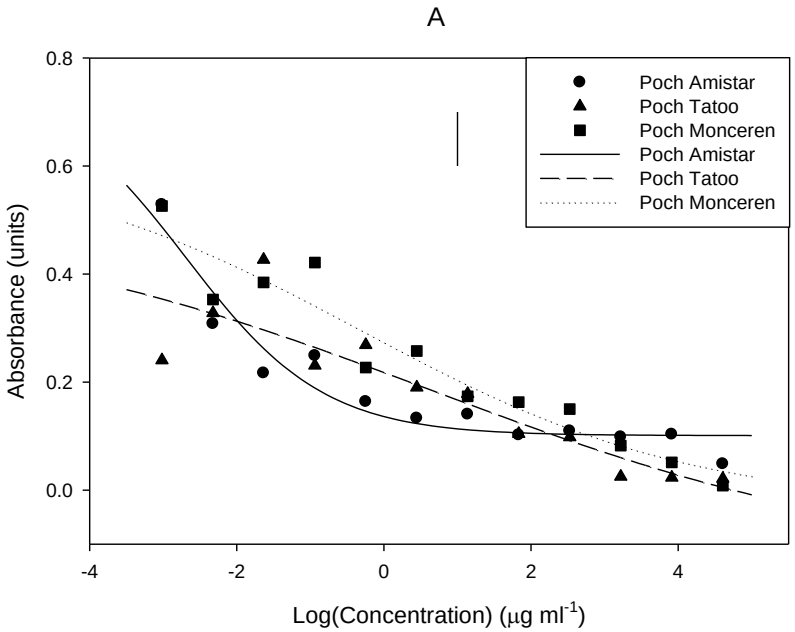


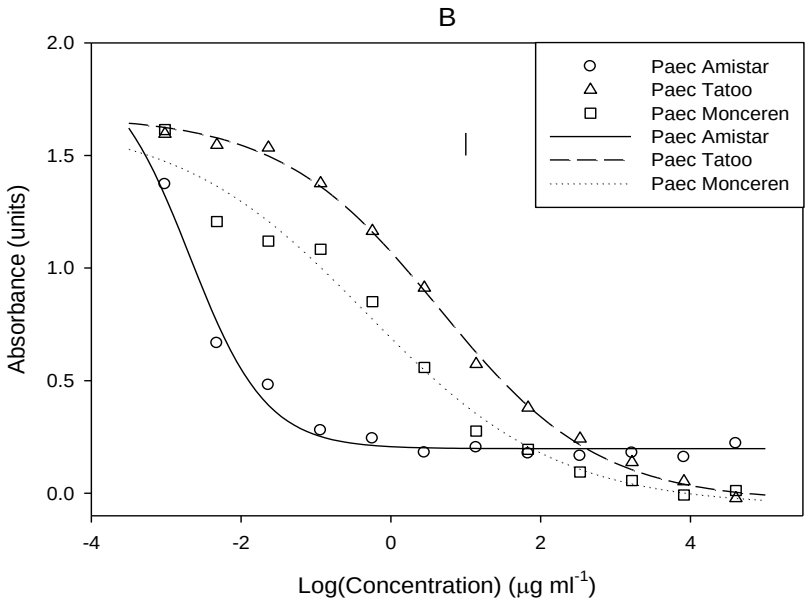
- The different concentrations of herbicide produced no significant effects on the growth of the fungus.
- Similar results were found for Basagran and Stomp, in both *Pochonia chlamydosporia* and *Paecilomyces lilacinus*.

Herbicides had no measurable effect on the growth of either biological control fungi in ELISA plate assays

Objective 4: . Assess effects of fungicides & herbicides on the associated microbes

Impact of three fungicides (Monceren, prothioconazool; Amistar, azoxystrobin; and Tatoo, carbamate) dose response curves



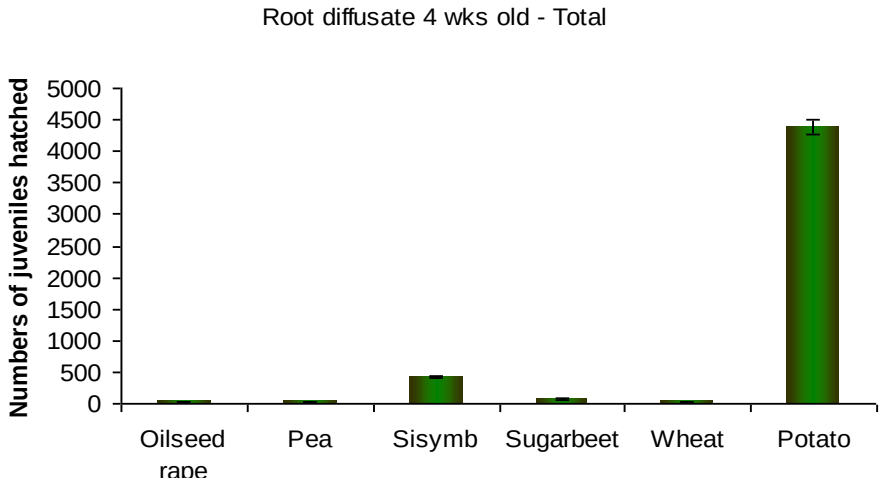


Pochonia chlamydosporia

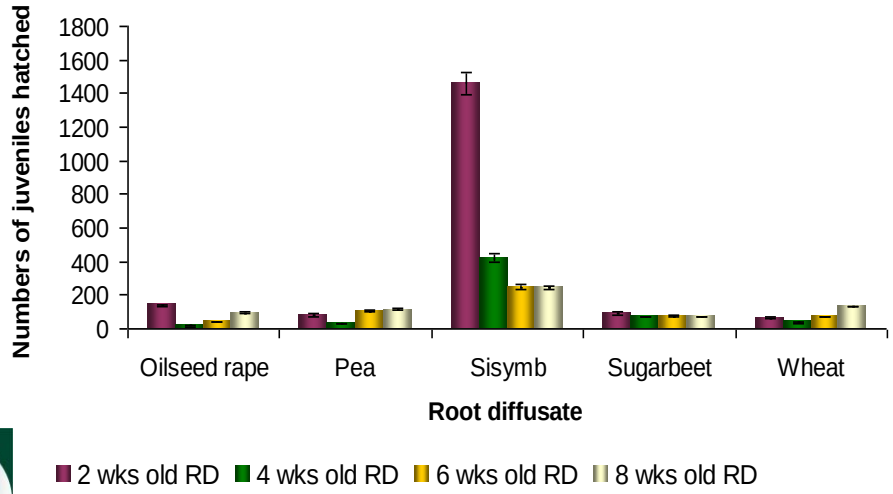
Paecilomyces lilacinus

Fungicides did have a major effect on *Paecilomyces lilacinus* but did not have and effect on *Pochonia chlamydosporia*

Objective 5: Investigate the biotic and abiotic factors that influence fungal growth

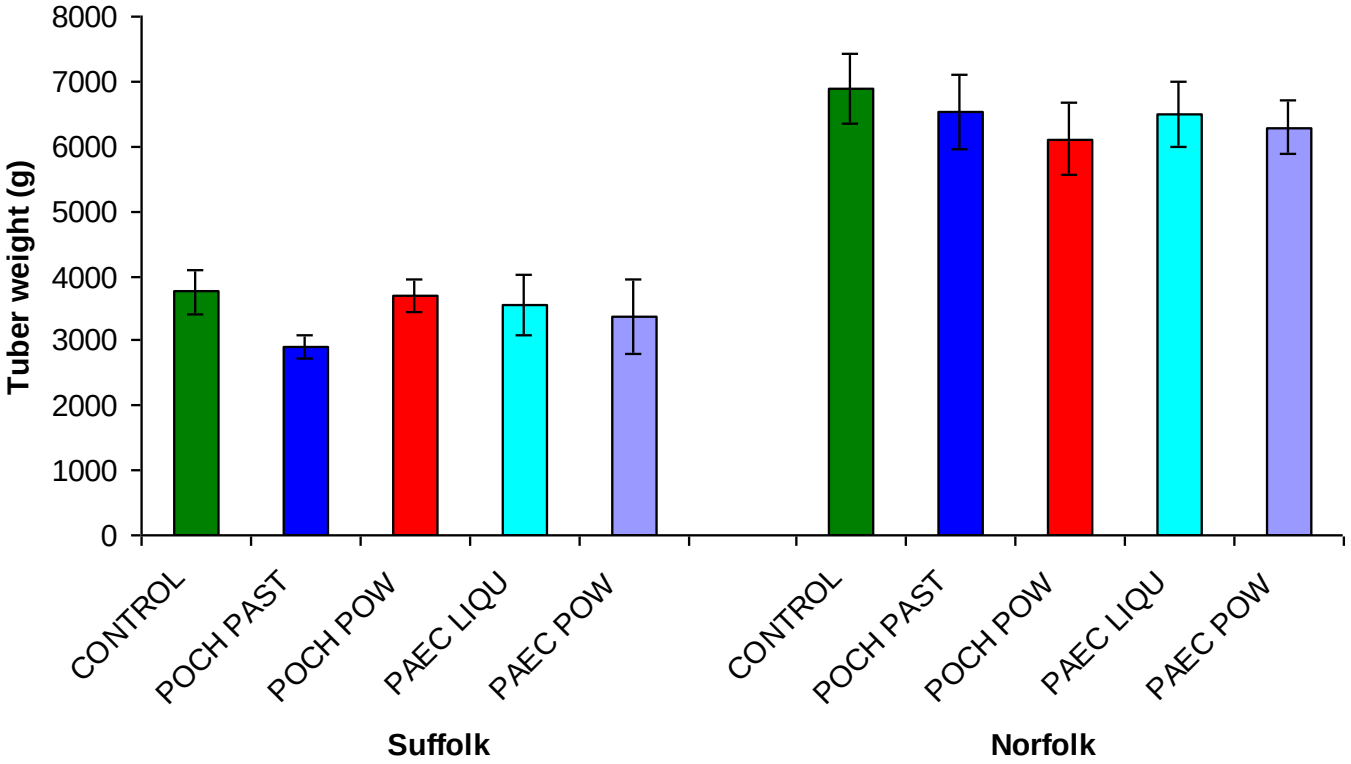


Potato root diffusate collected from 4 week old plants.



Potato root diffusate collected from a range of different aged plants.

Objective 6: Investigate potential formulation and delivery of fungal agents

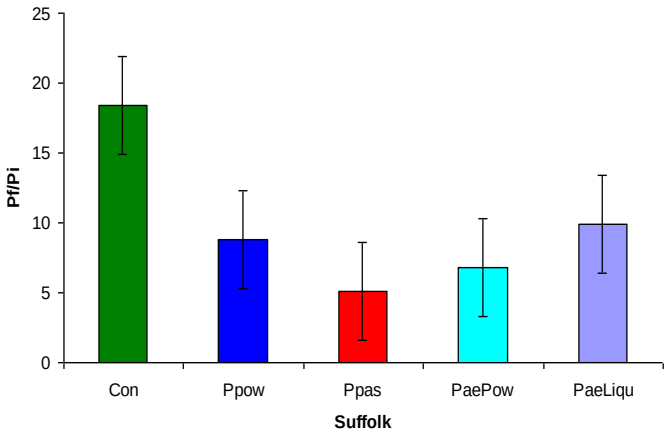


Yield of tubers per plot at two sites, Suffolk and Norfolk, comparing and untreated control with the biological control agents *Paecilomyces lilacinus* & *Pochonia chlamydosporia* with different formulations

Objective 6: Investigate potential formulation and delivery of fungal agents

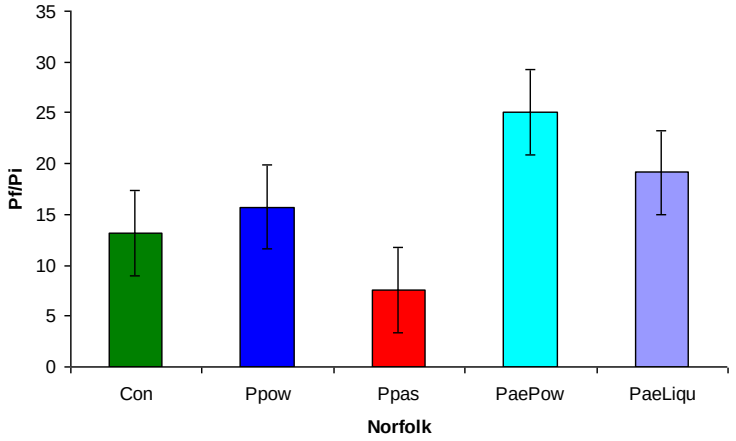
High *Paecilomyces*

X2 applications
0.1 gram inoculum per m^2



Low *Paecilomyces*

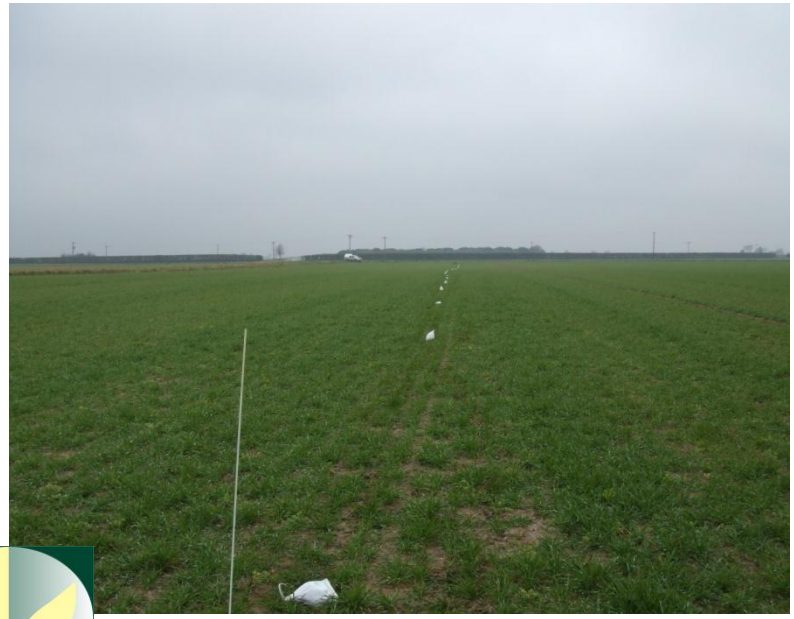
X1 application
0.1 gram inoculum per m^2

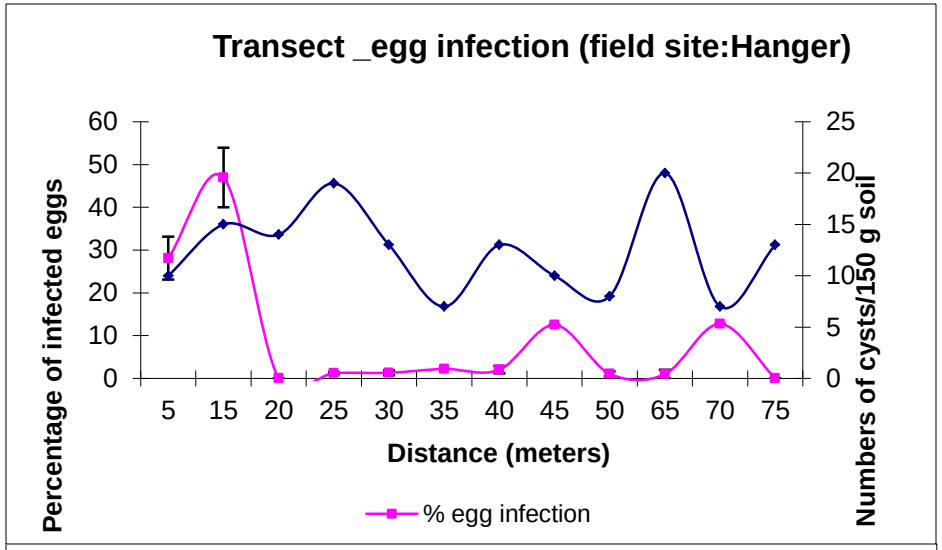


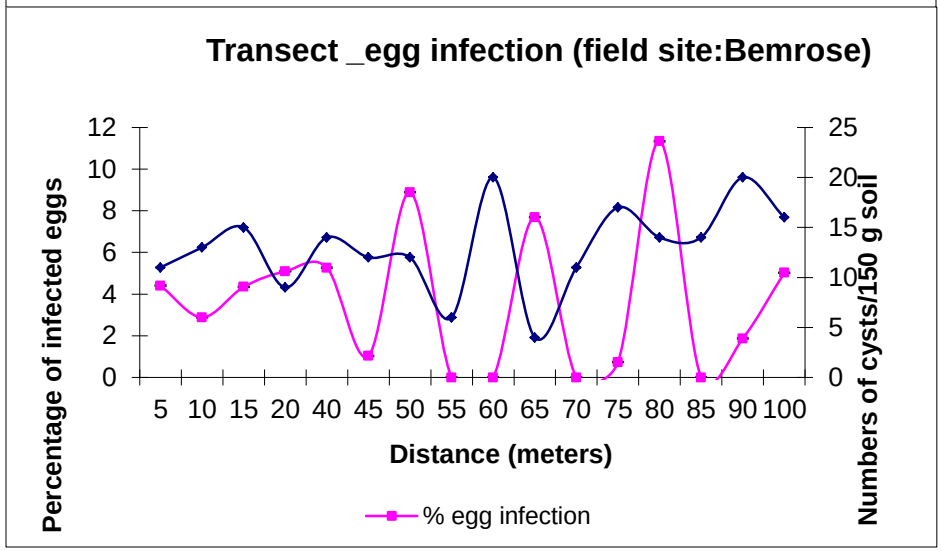
Pf/Pi ratio at two sites, Suffolk and Norfolk, comparing and untreated control with the biological control agents *Paecilomyces lilacinus* (PAEC), as a liquid (LIQU) or a wettable powder (POW) formulation, and *Pochonia chlamydosporia* (POCH) as a paste (PAST) of wettable powder (POW), (ANOVA between treatments $P < 0.05$).

Objective 8: Assess the importance of fungal parasites In patch dynamics

- Field PCN mapped
- Transect across a patch of PCN
- Cyst number and infection quantified







Summary and some key findings

- An inverse relationship was observed between eggs per cyst and fungal egg infection but this was dependent on soil type
- Break crops had little effect on decline, however, *S. sisymbrifolium* increased hatch
- Fungi were tolerant to herbicides but sensitive to fungicides
- Although application of fungi did not increase tuber yield it had a an effect on PCN multiplication rates
- The type of formulation of fungi did not have a significant effect

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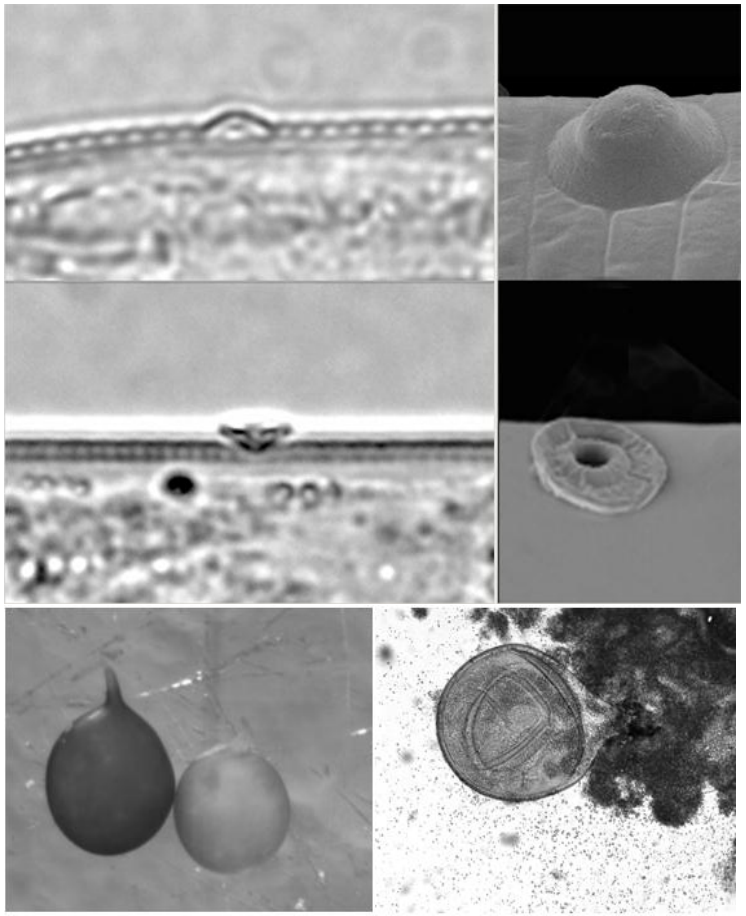
Multitrophic interactions in the rhizosphere



Pasteuria sp. found to be Parasitising *Heterodera cajani* also attaches to *Globadera pallida*

It germinates and infects *G. pallida*

Female becomes a cadaver full of spores

Sharad Mohan *et al*., submitted

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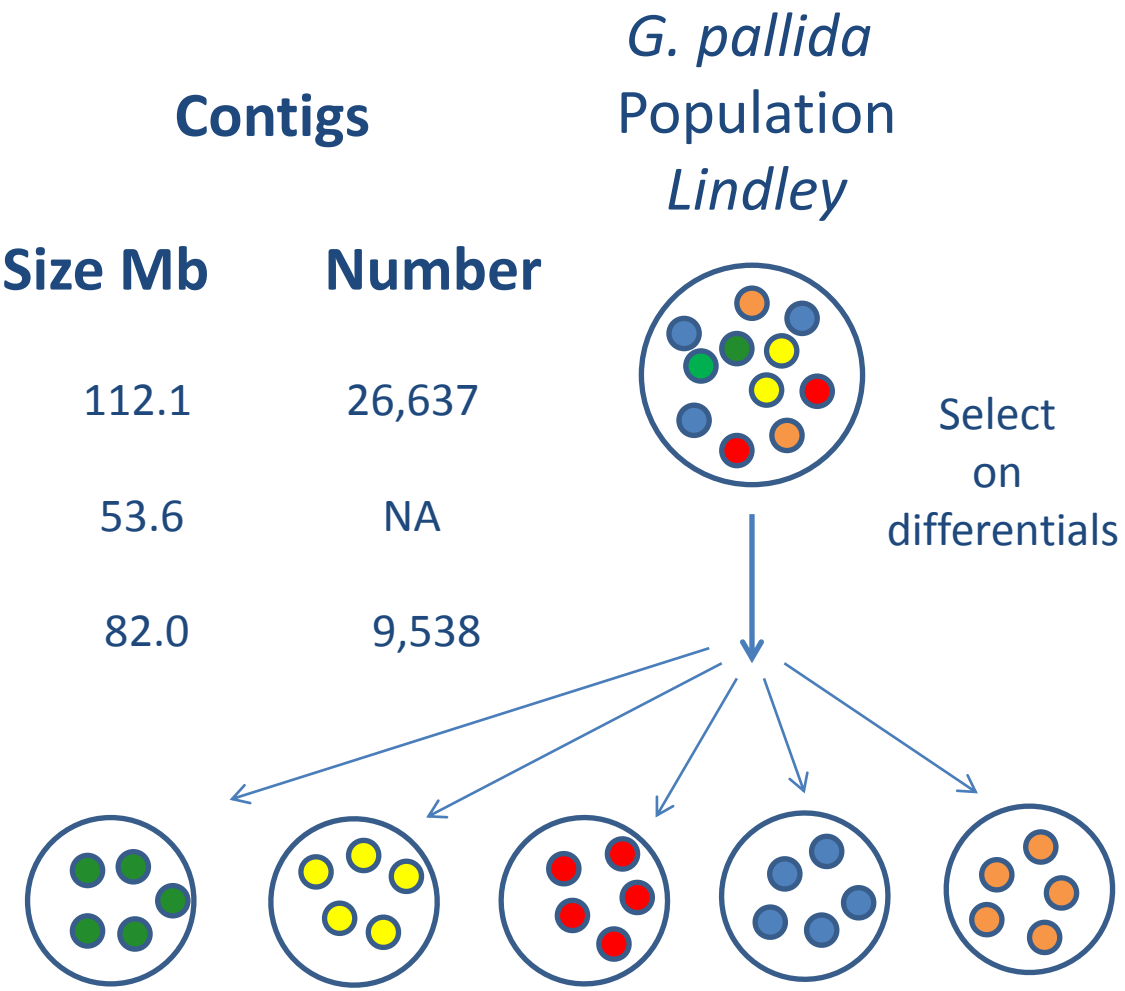
Globodera pallida genome sequence

Sanger Centre, Leeds University, SCRI & Rothamsted

	Contigs	
	Size Mb	**Number**
Globodera pallida	112.1	26,637
Meloidogyne hapla	53.6	NA
Meloidogyne incognita	82.0	9,538



Acknowledgements