Cavity spot of carrot: developing techniques for research and disease management

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Cavity spot

- Cavity spot is one of the biggest problems for carrot growers in the UK; estimated losses at least £5M per annum
- In the UK principally caused by the oomycete *P. violae* and to a lesser extent *P. sulcatum* – incidence of each species was unknown
- Other *Pythium* species associated with cavity spot include *P. intermedium* and *P. sylvaticum*
- Other fungi may cause similar root lesions or invade cavities e.g. *Cylindrocarpon destructans* and *Mycocentrospora acerina*

The problems

- **Interaction between components of the cavity spot complex unknown**
  - Relative importance of *P. violae*, *P. sulcatum*, *P. intermedium*
- **The disease is unpredictable**
  - Lack of understanding of key abiotic and biotic factors that enhance disease
  - Lack of understanding of biology of *P. violae* and timing of infection
- **Metalaxyl issues / lack of new actives**
  - Microbial degradation of metalaxyl / future withdrawal
  - Field trials to identify new control products / approaches challenging – lack of adequate disease levels
  - Lack of artificial inoculation approaches
- **Commercial carrot varieties lack good resistance**
  - Cv. Nairobi most widely grown – low-intermediate resistance

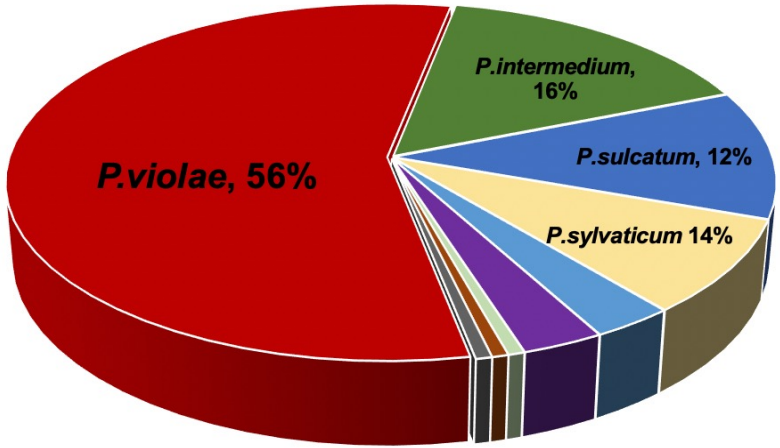
Developing techniques for research and control

1) **Identification of *Pythium* isolates** associated with cavity spot
   - Determine frequency of different *Pythium* spp. associated with cavity spot

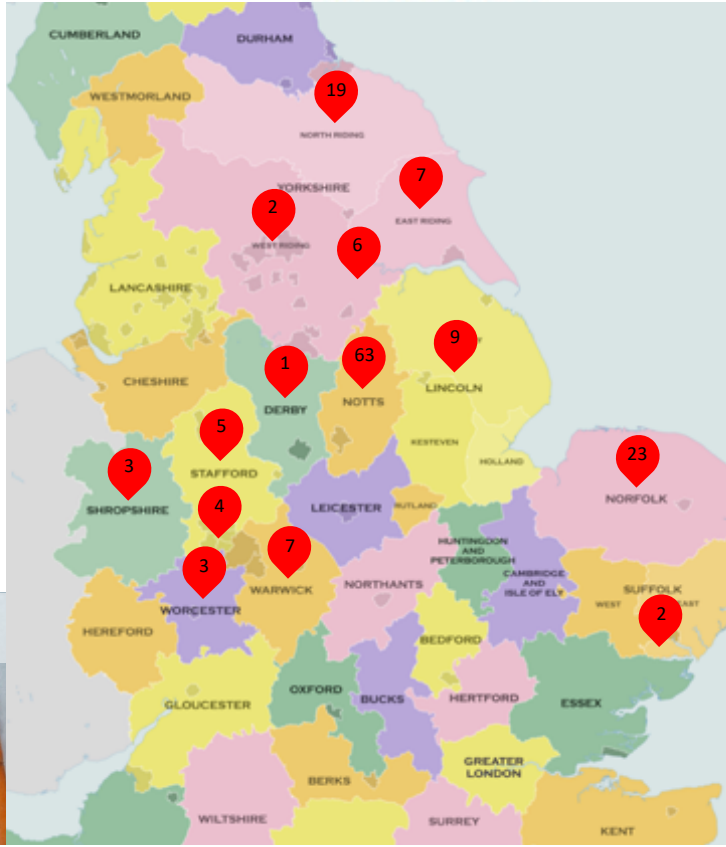
2) **Improve molecular detection of *Pythium violae*** in soil by PCR
   - Help determine inoculum levels and assess disease risk

3) **Develop artificial inoculation systems** to induce cavity spot disease to enable:
   - Identification of new crop protection products
   - Identification of new sources of plant resistance

P. violae is the major cavity spot pathogen in the UK



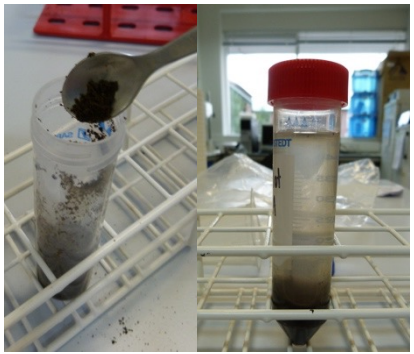
- *P.violae*
- *P.intermedium*
- *P.sulcatum*
- *P.sylvaticum*
- *Pythium spp.*
- *P.ultimum*
- *P.attrantheridium*
- *P.irregulare*
- *P.debaryanum*



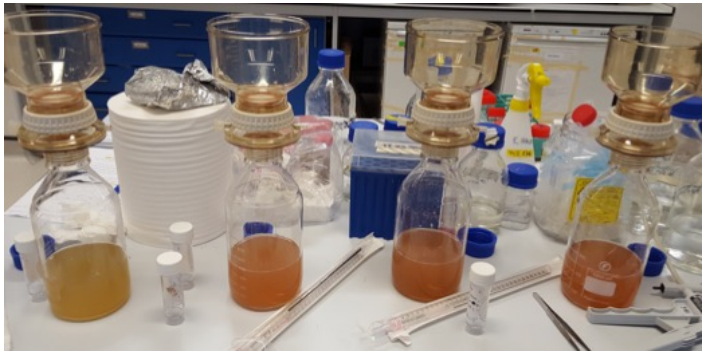
Cavity spot lesion size: *P. violae* > *P. sulcatum* > *P. intermedium*

Pythium oospore capture

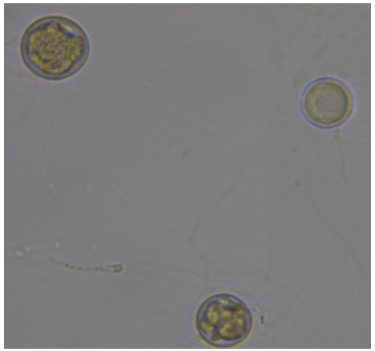
- *Pythium* often distributed unevenly: DNA extraction from small soil sample kits may give inconsistent detection
- A method of separating *Pythium* oospores from soil was developed to allow quantification from larger soil samples



Step 1. Sucrose flotation & centrifugation separates oospores from soil



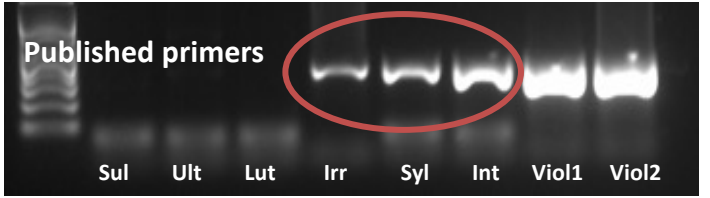
Step 2. Oospores captured on a filter membrane



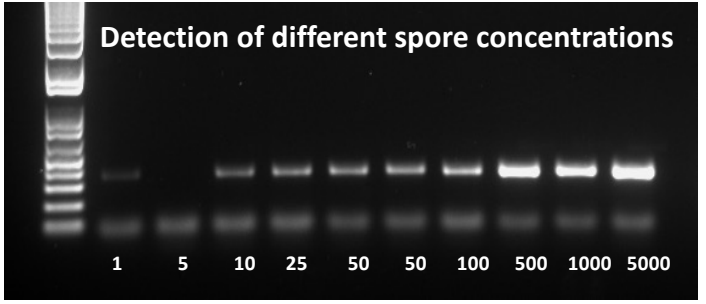
Step 3. Free oospores ready for DNA extraction / quantification

P. violae detection and quantification by PCR

- Published PCR primers amplified other *Pythium* species
- New primers developed were specific to *P. violae*
- Assay could detect 10 spores in solution; yet to be tested extensively in field



Sul: *P.sulcatum*, Ult: *P.ultimum*, Lut: *P.lutarium*. Irr: *P.irregulare*, Syl: *P.sylvaticum*, Int: *P.intermedium*, Viol1/2: *P.violae*

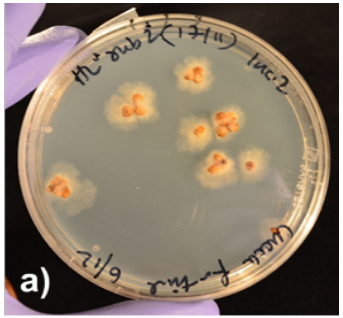


Artificial inoculation of carrots with *P. violae*

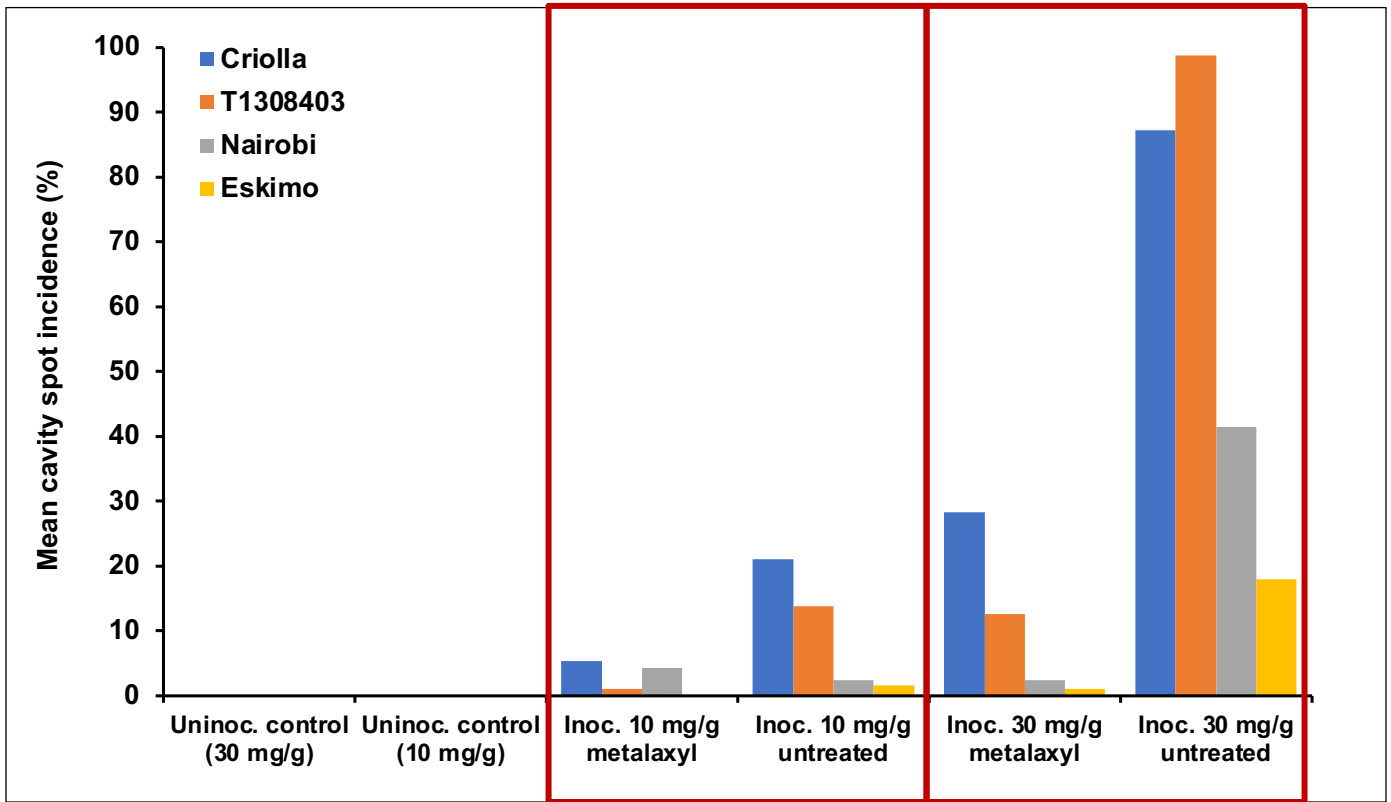
- *P. violae* oospores produced in sand / oat substrate
- Variable disease levels when used to inoculate glasshouse-grown carrots in pots but consistently high cavity spot incidence in field ‘macrocosms’
- Millet grain and compost/carrot inoculum more effective for glasshouse experiments

Inoculation of pot grown carrots with *P. violae* mycelium

- Millet grain inoculum used which is quicker to produced than oospores and resulted in:
  - Seedling damping off at higher levels
  - Reduction in carrot foliage
  - Production of stubby carrots
  - Reduction in root weight
  - Cavity spot incidence of 50%
  - Low cavity spot severity (mean 2-3 lesions / root)

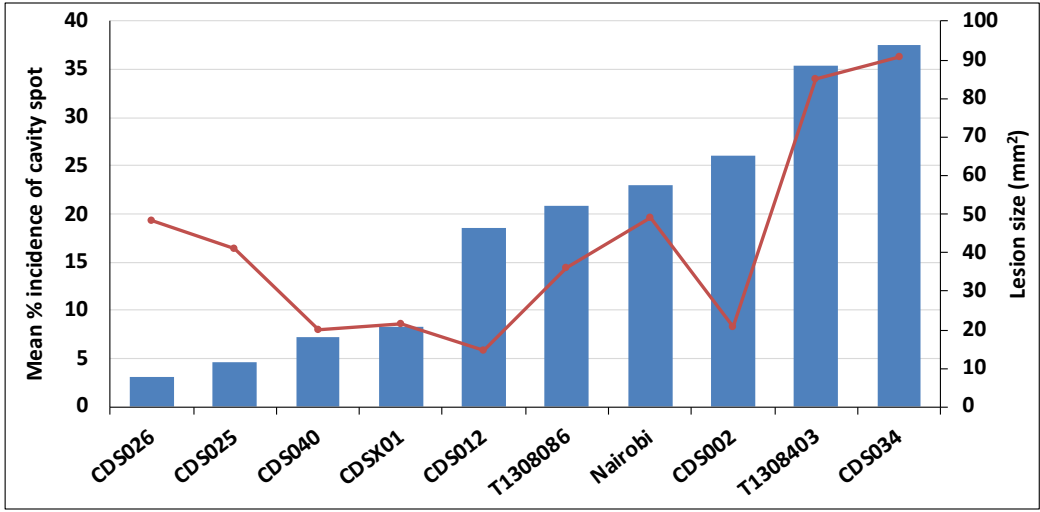


Metalaxyl and carrot variety reduces cavity spot in pot tests



Carrot resistance to cavity spot

- Glasshouse pot test: millet inoculum
- Differences between different carrot accessions
- Some relationship with *P. violae* agar plug test

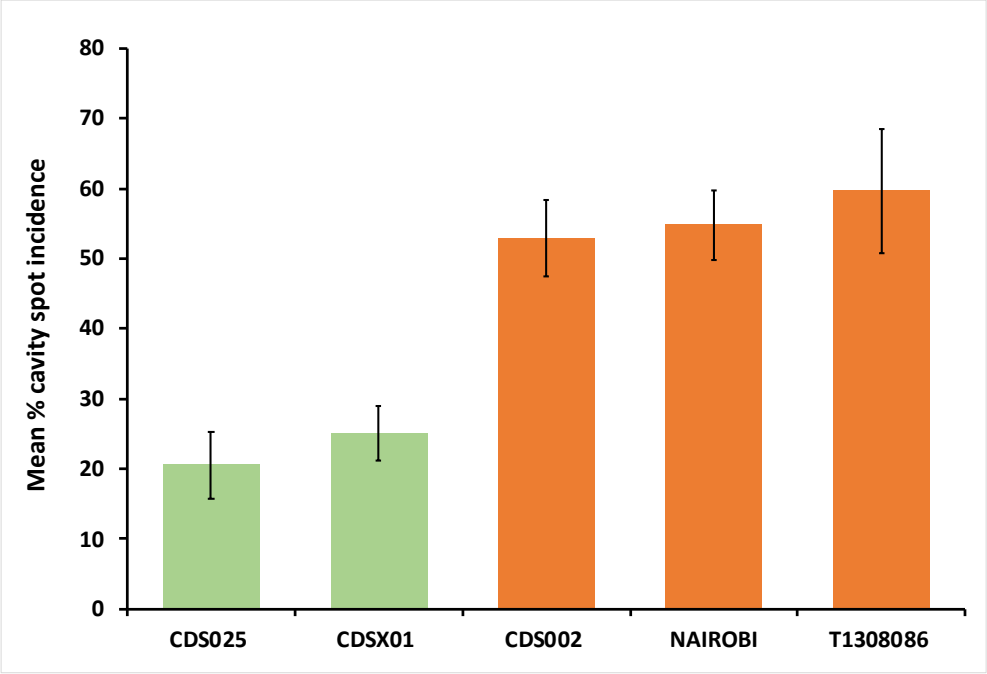


Inoculation of field macrocosms with *P. violae* oospores

- Normal growth of carrots
- Up to 40% cavity spot incidence, severity of 6 lesions / carrot

Carrot resistance to cavity spot

- Macrocosm field test: oospore inoculum
- Differences in resistance observed between carrot accessions
- Similar results to glasshouse pot test



Sceptre+ trial in progress

- Highly susceptible cv. Criolla used
- Treatments:
  - SL567a (metalaxyl)
  - Previcur Energy (propamocarb and fosetyl Al)
  - Trisoil (*Trichoderma atroviride* I-1237)
  - Ranman (cyazofamid)

Summary

- *P. violae* identified as main pathogen causing cavity spot but *P. sulcatum* / *intermedium* also present
- New PCR and oospore capture methods developed for *P. violae* detection and quantification
- Artificial inoculation methods developed for *P. violae* for pot and field grown carrots which are effective for testing new crop protection products and assessing cultivar resistance
- Tools now in place to investigate other approaches to cavity spot control (e.g. organic / inorganic soil amendments / biocontrol) and combining with new chemistry and carrot cultivars

Thank you to:

- Nicole Pereira, Kat Hales and Andy Taylor
- Growers esp. Rodger Hobson and Ian Holmes

Questions?